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A COST ANALYSIS FOR THE IMPLEMENTATION OF COMMONALITY IN THE FAMILY OF COMMUTER AIRPLANES

PREPARED FOR: NASA GRANT NGT-~~8001~~ 80001

PREPARED BY: LOUISE MORGAN
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AE 790 DESIGN TEAM
REVISED, APRIL 1987

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TEAM MEMBERS: RAFAEL HADDAD
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LIST OF SYMBOLS

Symbol	Definition	Units
A	AMPR weight	lbs
D	Development support cost	$
D_p	Propeller diameter	ft
E	Total airframe engineering hours	hrs
E_p	Engine power available	shp
F	Flight test operations cost	$
L	Manufacturing labor hours	hrs
M	Material and equipment costs	$
N	Number of engines	---
Q/C	Quality control hours	hrs
Q_D	Number of developmental airplanes	---
Q_P	Number of production airplanes	---
R	Airplane production rate	#/mnth
S	Maximum speed at best altitude	kts
T	Cumulative tooling hours	hrs

Subscripts

D	Development
p	Propeller
P	Production

Acronyms

AMPR	Aeronautical Manufacturers Planning Report.
CER	Cost Estimating Relationships
DT&E	Development, Test, and Evaluation
LCC	Life Cycle Cost
RDT&E	Research, Development, Test, and Evaluation

1. INTRODUCTION

This report presents the acquistion costs determined for the NASA family of commuter airplanes. The costs of the baseline designs are presented along with the calculated savings due to the commonality in the family. A sensitivity study is also presented to show the major drivers in the acquisition cost calculations.

Ref. 1 and Ref. 2 are previous reports detailing the designs for this family of commuter airplanes. Ref. 3 was used to calculate the cost of the advanced technology turboprop engines. Ref. 4 contained a method for determining the cost of the propellers. The development and production costs were calculated with the equations of Ref. 5. Input into estimating the rates for engineering, tooling, and manufacturing was given by Ref. 6 and Ref. 7. The avionics costs were estimated with the information in Ref. 8.

Chapter 2 presents the baseline costs as calculated with Nicolai's method. The commonality of the airplane designs will effect the calculated baseline costs, as presented in Chapter 3.

Chapter 4 presents a comparison of the estimated costs for this commuter family with the actual prices for existing commuters. Ref. 9 was used to obtain current cost statistics.

Chapter 5 shows the sensitivity of the acquisition cost to various parameters in the cost equations. The direct operating costs were then calculated with two different methods and the results are presented in Chapter 6.

Appendix A presents the cost calculations for the engines and counter-rotating propellers. Appendix B presents the baseline cost calculations for the various airplanes in the regional transport family.

The effects of commonality on acquistion costs are calculated in Appendix C. The Class II component weight breakdown of Ref. 2 was used in this analysis.

Appendix D shows the sensitivity calculations of the cost to various costing parameters. A computer spreadsheet, SuperCalc3, was used to make the necessary calculations.

Appendix E presents the calculations for the direct operating costs, with and without commonality.

2. BASELINE ACQUISITION COSTS

The purpose of this chapter is to present the baseline acquistion costs for the NASA family of regional turboprops as described in Ref. 1 and Ref. 2. The baseline costs are defined as the original costs calculated for each Class II commuter configuration. These baseline costs are computed for each airplane individually without accounting for any commonality in design or manufacture.

Multiple references were necessary to reasonably calculate the acquisition costs for the commuters. Ref. 3 was used to calculate the engine costs. Ref. 4 served as a source for propeller cost analysis. The majority of the manufacturing and development costs were estimated with the help of Ref. 5. Ref. 6 and Ref. 7 were used to estimate the hourly rates for engineering, tooling, and manufacturing. The avionics cost was approximated with the information in Ref. 8.

The engineering calculations for both the engines and the propellers are contained in Appendix A. Appendix B shows the calculation details for the baseline cost of each airplane in the family. The cost equations of Ref. 5 were programmed into a computer spreadsheet to generate the engineering calculation printouts.

The total cost per airplane for each airplane size is presented in Table 2.1. Since the equations of Ref. 3 are based on conventional single-body configurations, the estimated cost of both the 75 passenger and the 100 passenger single-body airplanes are also presented. The savings in empty weight between these airplanes and their twin-body counterparts translated directly into a savings in cost. These baseline costs are also shown in Figure 2.1, for ease of comparison.

Several assumptions were made in the cost calculations. First, it was necessary to estimate a cost escalation factor to extrapolate the costs into the mid 1990's. By studying financial trends and with the help of the financial statistics of Ref. 10, the cost escalation factor was estimated as 3.00. This does depend on the inflation rate and other economic conditions, so this could vary in the cost projection.

All of Nicolai's costing equations are based on the AMPR weight of the airplane. Since this weight is not known specifically for each of these airplanes, it was necessary to estimate a value. From the statistics in Ref. 5, an average ratio of AMPR weight to airplane empty weight was calculated to be 0.66. This ratio was utilized to estimate the AMPR weights.

The avionics cost was roughly determined with the help of Ref. 8. However, there are so many variations even in the same category of equipment that the actual cost could easily change. For increased fine tuning of the avionics cost, more specifications on the needed avionics characteristics would be required.

The cost figures quoted for initial production include the amortization of the development, testing, and evaluation. These costs are estimated to spread over the first four years of production, which translates into the first 192 airplanes produced in each size category. The figures quoted for further production do not include DT&E costs. It was assumed that 500 production airplanes of each size would be produced overall.

Table 2.1--Baseline Acquisition Costs.

Airplane	Initial Prod. (incl. DT&E)	Additional Prod. (Production only)
25 Pax	8,667,362	7,363,869
36 Pax	9,490,391	7,948,048
50 Pax	10,428,089	8,611,920
75 Twin	15,682,836	13,069,259
100 Twin	17,121,109	14,079,259
75 Single	16,981,832	13,981,566
100 Single	19,652,852	15,851,342

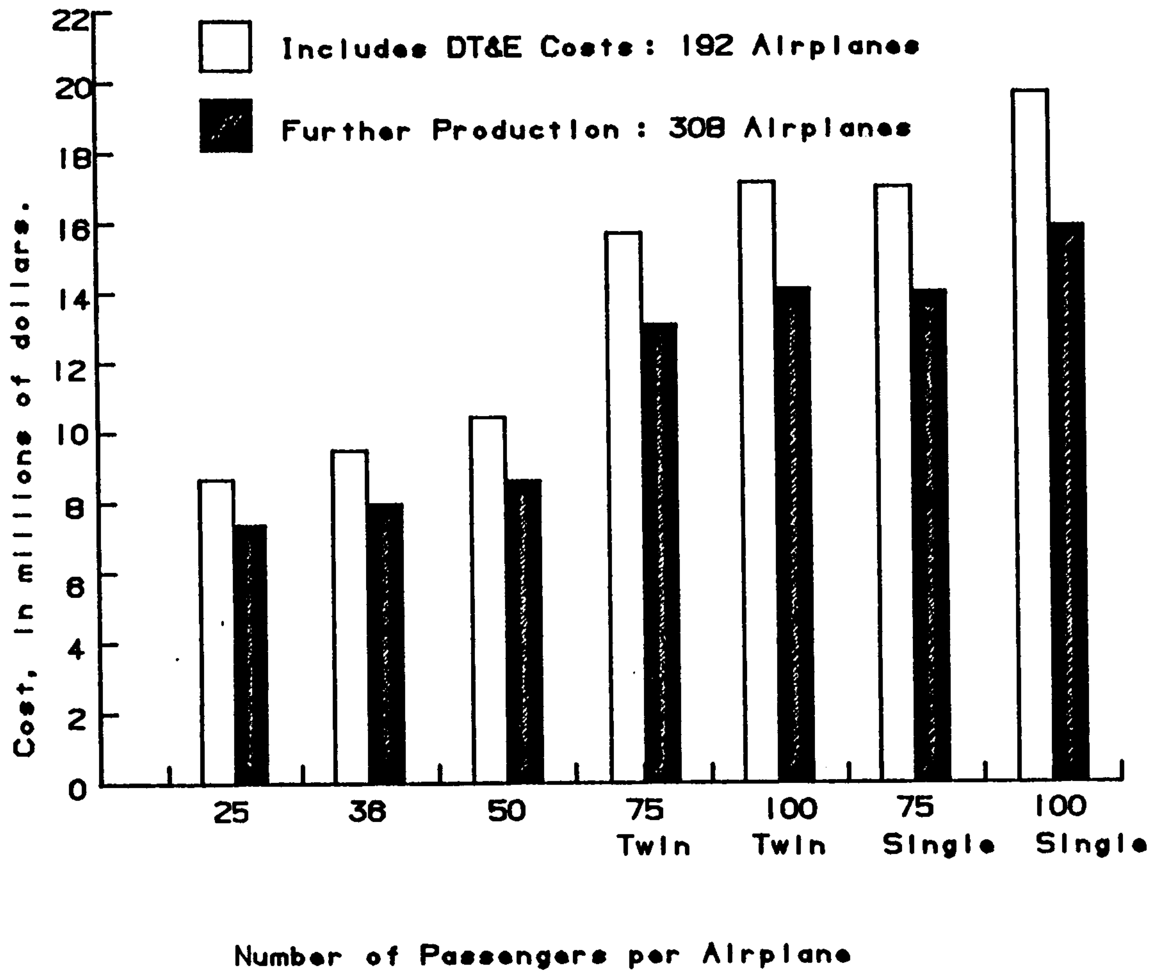

Figure 2.1--Baseline Costs for NASA Family of Commuters.

3. EFFECT OF COMMONALITY IMPLEMENTATION

The purpose of this chapter is to present the effects of commonality on the acquisition costs of the commuter family. Several parts of the commuter were designed to be interchangeable between the different airplanes. These are:

1. Nose gear.
2. Main gear.
3. Vertical tail.
4. Horizontal tail.
5. Nose cone.
6. Fuselage section with wing torque box.
7. Tail cone.
8. Wing.

By producing these pieces of the airplanes in greater quantities, it was hoped that the cost of the airplanes could be driven lower than normally would be possible if each airplane were developed individually. This is the theory of commonality.

Appendix C contains the detailed printouts of the commonality trade study. By utilizing commonality in the airplane designs, the empty weights of four sizes of airplanes were increased. This phenomenon creates an initial cost penalty in those airplanes due to the additional weight. However, the mass production of the common parts produces an average savings per common part. When added together, the savings per part sums to an overall savings per airplane. This savings offset the initial penalty due to weight, so the overall airplane costs are driven below the baseline costs.

As shown in Appendix C, the decrease in cost due to commonality is a result of several factors. Tooling costs decrease as less dies have to be made and workers become much more efficient as production amounts increase. The cost of raw materials decreases with a larger common inventory. Manufacturing labor and quality control become more efficient with increased exposure to the same products. These are all general reasons why the concept of common airplane parts can be a large contributor to keeping acquisition costs low.

Tables 3.1 through 3.6 show in detail the savings which were gained by producing the parts common to all the airplanes. Table 3.7 contains the average savings achieved by all the common production sections. A comparison of acquisition costs with and without the commonality implemented is given in Table 3.8.

Figure 3.1 shows the baseline costs for the airplanes relative to the costs with commonality implemented. The average savings per airplane shifted the cost curve down as shown in Figure 3.2.

Systems commonality was accounted for in the baseline acquisition cost models. From a maintenance and spares point of view, this type of commonality was so desirable that it was designed in initially. The configuration of the systems will be common through the entire fleet, with increasing system weights resulting from more of each component on the larger airplanes. It was a decision of the design team that a 10% reduction in DOC maintenance costs could be assumed due to the system commonality.

Commonalizing the handling qualities of the commuter family was important for pilot certification and education. The direct operating costs will be kept lower as the airliners can cross-certify pilots to fly all of the airplanes in the fleet. Less crews will be needed as stand-by. It will also benefit the manufacturer by keeping the FAA certification costs much lower.

The effects of commonality on the numerical estimates for the direct and indirect operating costs is included in Chapter 6.

Table 3.1--Nose Gear Cost Breakdowns for Commuter Family (Production Phase).

Airplane	Tooling	Man Lab	Mat & Eq	Q/C
25 Pax	5645070	46803957	17267852	6084514
36 Pax	7012650	57747851	20999188	7507221
50 Pax	8263730	67700240	24349931	8801031
75 Pax	10217752	83152202	29486821	10809786
100 Pax	11307754	91730106	32309298	11924914
Total	42446956	3.4713e8	1.2441e8	45127466
Common	14855081	1.9328e8	1.1451e8	25126746
Diff.	27591875	1.5385e8	9903090	20000720
Dif/Plane	11036.75	61541.74	3961.236	8000.288

Total diff./plane= 84540.02

Table 3.2--Main Gear Cost Breakdowns for Commuter Family (Production Phase).

Airplane	Tooling	Man Lab	Mat & Eq	Q/C
25 Pax	15672739	1.2584e8	43368956	16359510
36 Pax	20641698	1.6431e8	55595368	21360615
50 Pax	25383724	2.0075e8	66993414	26097711
75 Pax	33108063	2.5966e8	85130292	33756421
100 Pax	40890026	3.1858e8	1.0298e8	41415213
Total	1.3570e8	1.0691e9	3.5407e8	1.3899e8
Common	45630393	5.7314e8	3.1506e8	74508377
Diff.	90065857	4.96e8	39008030	64481093
Dif/Plane	36026.34	198400	15603.21	25792.44

Total diff./plane= 275822.0

Table 3.3--Vertical Tail Cost Breakdowns for Commuter Family (Production Phase).

Airplane	Tooling	Man Lab	Mat & Eq	Q/C
25 Pax	7291874	59973607	21751785	7796569
36 Pax	7801916	64032416	23119295	8324214
50 Pax	8434852	69057665	24804199	8977496
75 Pax	13249155	1.0695e8	37272133	13902901
100 Pax	14324002	1.1534e8	39988479	14993998
Total	51101799	4.1535e8	1.4694e8	53995178
Common	15162692	1.9716e8	1.1665e8	25630550
Diff.	35939107	2.1819e8	30285891	28364628
Dif/Plane	14375.64	87277.48	12114.36	11345.85

Total diff./plane= 125113.3

Table 3.4--Horizontal Tail Cost Breakdowns for Commuter Family (Production Phase).

Airplane	Tooling	Man Lab	Mat & Eq	Q/C
25 Pax	3927053	32932970	12448220	4281286
36 Pax	3927053	32932970	12448220	4281286
50 Pax	5623601	46631532	17208615	6062099
75 Pax	19627608	1.5649e8	53126142	20343373
100 Pax	19627608	1.5649e8	53126142	20343373
Total	52732923	4.2548e8	1.4836e8	55311417
Common				
All	9312324	1.1161e8	61997180	14509573
75,100	22026629	1.9742e8	79791215	25664095
Total	31338953	3.0903e8	1.4179e8	40173668
Diff.	21393970	1.1645e8	6568944	15137749
Dif/Plane	8557.588	46578.99	2627.578	6055.100

Total diff./plane= 63819.25

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Table 3.5--Fuselage Cost Breakdowns For Commuter Family (Production Phase).

Airplane	Tooling	Man Lab	Mat & Eq	Q/C
25 Pax	32435063	2.5455e8	83568124	33091583
36 Pax	49897640	3.8633e8	1.2324e8	50223435
50 Pax	68547901	5.2547e8	1.6410e8	68310614
75 Pax	84735798	6.4525e8	1.9868e8	83881968
100 Pax	1.1641e8	8.7762e8	2.6456e8	1.1409e8
Total	3.5203e8	2.6892e9	8.3415e8	3.4960e8
Common				
All	62221679	7.7396e8	4.1673e8	1.0061e8
36, 75	36693290	3.6368e8	1.5942e8	47277814
50, 100	67061644	6.5219e8	2.7462e8	84784818
Total	1.6598e8	1.7898e9	8.5077e8	2.3267e8
Diff.	1.8605e8	8.9939e8	-1.662e7	1.1692e8
Dif/Plane	74419.92	359756	-6648.75	46769.99

Total diff./fus. = 474297.2

Table 3.6--Wing Cost Breakdowns for Commuter Family (Production Phase).

Airplane	Tooling	Man Lab	Mat & Eq	Q/C
25 Pax	27369592	2.1595e8	71702408	28072932
36 Pax	32347507	2.5389e8	83364658	33005058
50 Pax	43369577	3.3727e8	1.0860e8	43845449
75 Pax	45288198	3.5171e8	1.1292e8	45722904
100 Pax	59123081	4.5533e8	1.4361e8	59192816
Total	2.0750e8	1.6142e9	5.2020e8	2.0984e8
Common				
All	71817258	8.0726e8	3.9125e8	1.0494e8
75,100	33826649	2.9912e8	1.1748e8	38885187
Total	1.0564e8	1.1064e9	5.0873e8	1.4383e8
Diff.	1.0185e8	5.0777e8	11467067	66013972
Dif/Plane	40741.62	203108	4586.827	26405.59

Total diff./plane= 274842.0

Table 3.7--Average Savings Due to Common Production Parts.

Component	Tooling	Man Lab	Mat & Eq	O/C	Total
Nose Gear	11037	61542	3961	8000	84540
Main Gear	36026	198400	15603	25793	275822
Ver. Tail	14376	87277	12114	11346	125113
Hor. Tail	8558	46579	2627	6055	63819
Fus. Secs	74420	359756	-6649	46770	474297
Wing	40742	203108	4587	26405	274842
Totals	185159	956662	32243	124369	1298433

Table 3.8--Comparison of Acquisition Costs.

Airplane	Baseline	With Commonality
25 Pax	7363869	6065436
36 Pax	7948048	6649615
50 Pax	8611920	7313487
75 Pax	13069259	11770826
100 Pax	14079259	12780826

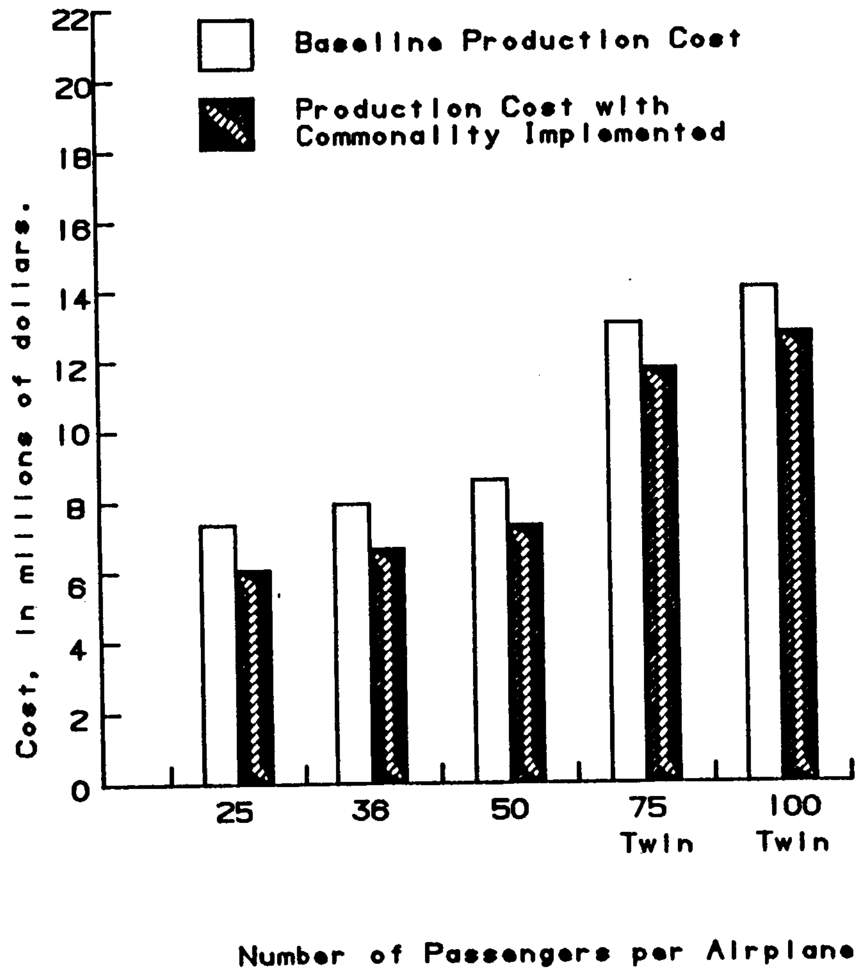

Figure 3.1--Cost Comparison for NASA Family of Commuters.

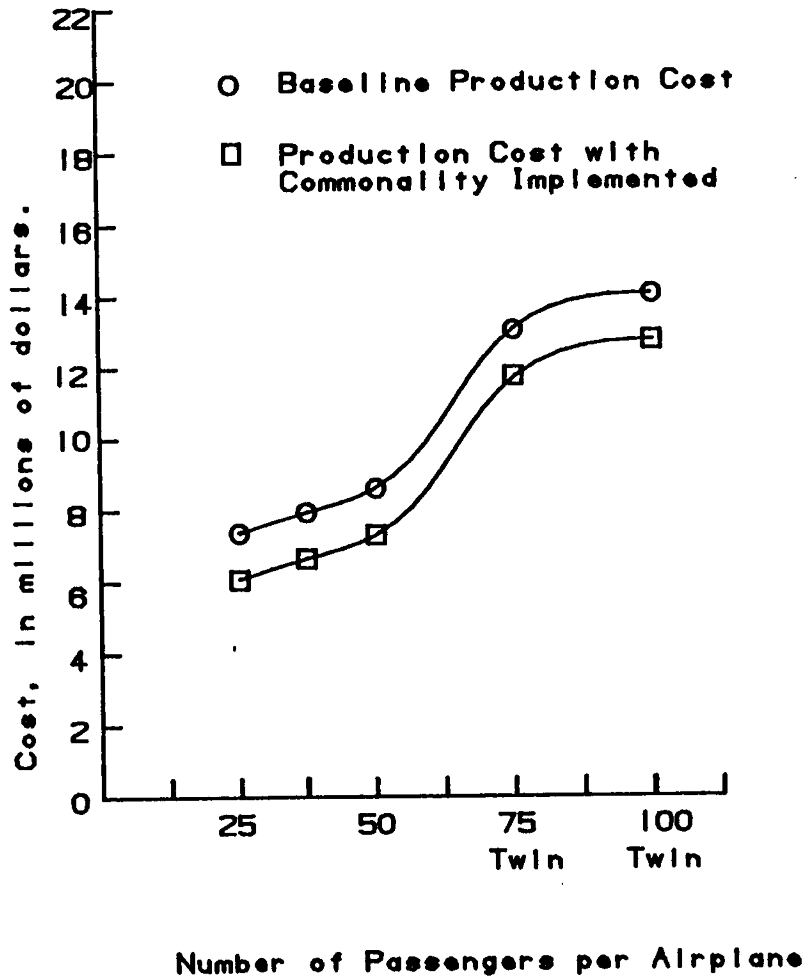

Figure 3.2--Cost Comparison for NASA Family of Commuters.

4. COMPARISON WITH EXISTING AIRPLANES

The purpose of this chapter is to gain the necessary perspective to interpret the cost figures presented within this report. Ref. 9 was used to obtain many of the cost figures of current production commuter airplanes.

Table 4.1 contains the prices quoted for the various commuters. The ballpark range in price is from 3 million to 16 million. These prices are graphed as a function of payload in Figure 4.1.

All existing commuters used for this comparison are pressurized airplanes. Most of them are not US companies. The only US commuter airplanes listed were in the 9 to 20 passenger range, which is not really in the design range for this family of commuters.

Many of the existing commuter airplanes were designed for a much lower cruise speed and a shorter range with full passenger loads. These factors affect the costing analysis, so direct cost comparisons would only be legitimate between airplanes of equivalent performance specifications.

Table 4.1--Acquisition Costs of Existing Commuter Airplanes.

Airplane	Number of Passengers	Price-US$ Millions
ATR 42-200	46	7.00
ATR 72	70	8.65
BAC Jetstream 31	18	2.85
BAC Super 748	48	6.00
BAC ATP	64	9.20
BAC 146-100	82	14.00
BAC 146-200	100	15.00
IPTN CN-235	44	5.70
DHC Dash 7	50	7.50
DHC Dash 8	37	5.50
EMB-120 Brasilia	30	4.99
Fokker F27 Mk500	52	6.50
Fokker 50	50	7.50
Fokker F28 Mk3000	65	9.00
Fokker F28 Mk4000	85	12.00
Fokker 100	107	16.00
Saab 340	35	5.75

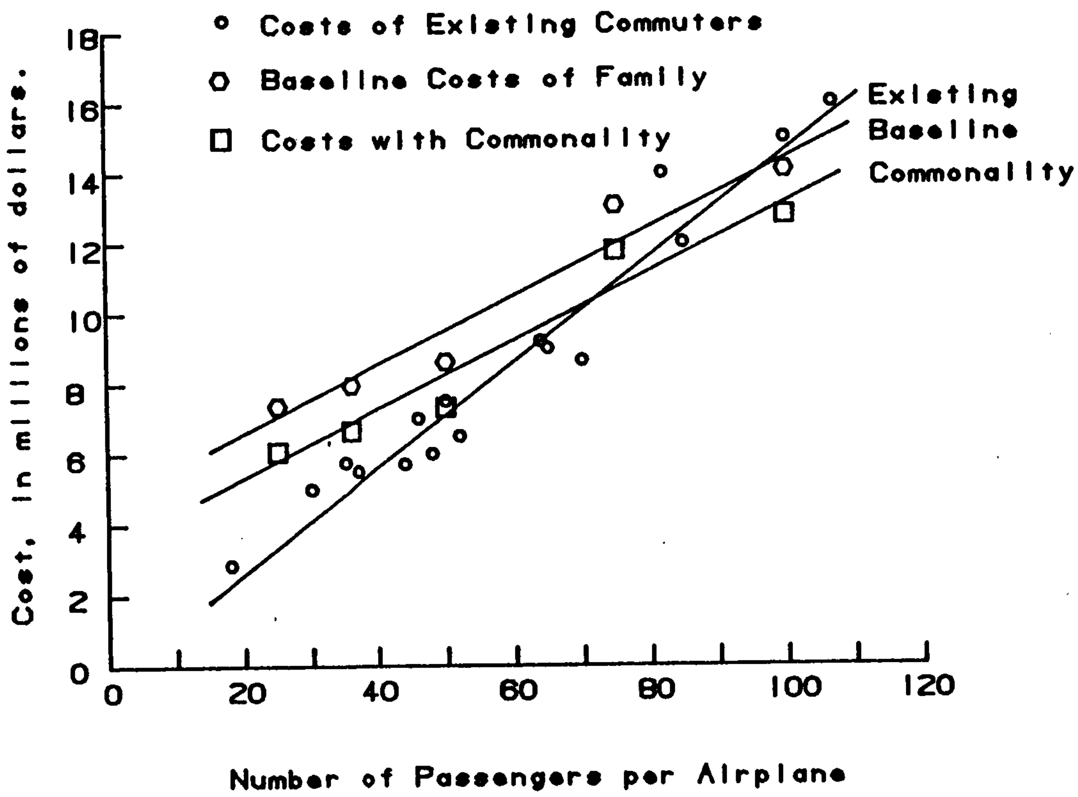

Figure 4.1--Cost Comparison for Existing Commuters and the Proposed Family of Commuters.

According to the comparison of Figure 4.1, the initial baseline costs calculated for the commuter family are reasonable or low at the higher passenger capacities. However, the numbers appear too high at the lower end of the passenger spectrum. Implementing commonality evenly over the entire family shifts the cost curve down and to the right as shown in Fig. 3.2. This decrease in cost which the commonality provides could be applied to the family in a more tailored fashion to achieve a cost curve comparable with existing prices.

5. SENSITIVITY ANALYSIS

The purpose of this chapter is to present the sensitivity of the airplane costs to various costing parameters. A computer spreadsheet was used to generate the actual sensitivites for each airplane individually. Appendix D contains the detailed calculations for this chapter.

The sensitivity equations were found by calculating the partial derivatives for Nicolai's cost equations. The derivatives were also calculated for the engine and the propeller cost equations.

Section D1 of Appendix D contains the calculated sensitivities for the development phase. These numbers are for the entire quantity of development models, which was selected as three (3). Section D2 shows the calculated senstivities for the production models of the commuter family. The numbers shown there are per the entire quantity of production airplanes, chosen to be 500 airplanes.

In the production phase, the maximum cruising speed, S, appears to be the major driver for the engineering cost, the manufacturing labor cost, and the quality control cost. The quantity of airplanes, Q, is the most influential variable for the the material and equipment cost. The cost of tooling is most influenced by the rate of production, R, and it is also the only cost affected by the production rate.

In the development phase, the quantity of airplanes is the major driver in every cost equation. For the tooling costs, the production rate is second to the quantity. The cruising speed becomes the second most influential variable in all other equations, while the AMPR weight is least influential.

$5,572/block hour for the 100 passenger model. This is further broken down per passenger per flight, costing on the order of $97 per flight for a customer on the 25 passenger airplane. This decreases to only $36 per flight for a customer on the 100 passenger commuter.

8. Commonality among the commuter family brought the direct operating costs down between 9 and 10%. Table 6.1 through 6.3 contain the calculated costs.

7.2 Recommendations

1. Tailoring of the cost curve for actual airplane acquisition pricing should be considered to better compete in all areas of the commuter market.

2. Direct operating costs should be further researched for the commuter family. Detailed analysis into the theory of the DOC calculations would lead to more precise conclusions.

3. Trade studies and market surveys will give addiitional insight into the feasibility of the proposed cost model for this project.

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APPENDIX A: ENGINE AND PROPELLER COSTS.

The purpose of this appendix is to show the detailed engineering calculations for the engine costs and the propeller costs. Ref. 1 and Ref. 2 were used as sources for the necessary data. Ref. 4 contained equations to estimate propeller costs and Ref. 3 presented information on engine costing.

Contents

A1. Propeller Costs: (Method of Ref. 4)

Eqn.: $\text{Cost/prop} = \$350.11 * D_p^{\,2} * (E_p/D_p^{\,2})^{0.12}$

1.1. Engine: E_p = 5500 shp, D_p = 10 ft.

$\text{Cost/prop} = \$350.11*(10)^2*(5500/100)^{0.12}$

Cost = \$56,630/prop * (2 prop/eng)* 3

<u>Cost/eng. = \$339,781</u>

1.2 Engine: E_p = 11,000 shp, D_p = 14 ft.

$\text{Cost/prop} = \$350.11*(14)^2*(11000/(14)^2)^{0.12}$

Cost = \$111,265/prop* (2 prop/eng) *3

<u>Cost/eng = \$667,590</u>

A2. Engine Costs: (Method of Ref. 3)

Eqn.: $\text{Cost} = 1.9089 \times 10^6\ (\text{shp}/10^4)^{0.8}$

2.1 Engine: Shp = 5500 shp.

$\text{Cost/eng.} = 1.9089 \times 10^6 \times (5500/10^4)^{0.8}$

<u>Cost/eng. = \$1,183,241.</u>

2.2 Engine: Shp = 11,000 shp.

$\text{Cost/eng.} = 1.9089 \times 10^6 \times (11{,}000/10^4)^{0.8}$

<u>Cost/eng. = \$2,060,143.</u>

A3. Total powerplant costs.

Table A.1--Powerplant costs.

SHP	Engine	Props.	Total
5500	1,183,241	339,781	$1,523,022
11000	2,060,143	667,590	$2,727,733

APPENDIX B: DETAILED CALCULATIONS OF BASELINE ACQUISITION COSTS.

The purpose of this appendix is to provide insight into the engineering calculations for baseline acquisition costs. These estimate both the initial estimated pricing needed to offset the RDT&E costs, and the subsequent pricing for additional production airplanes. The calculations were done with the help of a SuperCalc3 spreadsheet using the equations of Ref. 5.

Contents

B1. COST ANALYSIS FOR NASA COMMUTER FAMILY: 25 PAX

Development and Production Costs

Input:	Time =	1987
	Empty Weight (lbs) =	16050
	AMPR/Empty Weight =	.66
	AMPR Weight, A (lbs) =	10593
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4
	Flight Test Rate =	1
	Total Production, Q D + Q P =	503
	Engine =	1523022
	Avionics =	750000
	Engineering Dollar Rate =	65
	Cost Escalation Factor =	3
	Manufacturing Dollar Rate =	50
	Tooling Dollar Rate =	55

1. Engineering Hours:

E = 0.0396*(A)^0.791*(S)^1.526*(Q)^0.183 (24-1)

Development:

D, (hours) = 722988.7
Rate = 65
Cost, dollars = 46994268

Production:

E, (hours) = 1122899.
Rate = 65
Cost, dollars = 72988435

2. Development support:

D = 0.008325*(A)^0.873*(S)^1.89*(Q D)^0.346 (24-2)

D, dollars = 10437266

3. Flight Test Operations:

F = 0.001244*(A)^1.16*(S)^1.371*(Q D)^1.281 (24-3)

F, dollars = 2736403.

4. Tooling:

T = 4.0127*(A)^0.764*(S)^0.899*(Q)^0.178*(R)^0.066 (24-4)

Development:

T, hours =	1425632.
Rate =	55
Cost, dollars=	78409740

Production:

T, hours =	2122166.
Rate =	55
Cost, dollars =	1.1672e8

5. Manufacturing Labor:

L = 28.984*(A)^0.74*(S)^0.543*(Q)^0.524 (24-5)

Development:

L, hours =	1289951.
Rate =	50
Cost, dollars =	64497531

Production:

L, hours =	17597928
Rate =	50
Cost, dollars =	8.7990e8

6. Quality Control:

Q/C = 0.13*L (24-6)

Development:

Q/C, hours =	167693.6
Rate =	50
Cost, dollars =	8384679.

Production:

Q/C, hours =	2287731.
Rate =	50
Cost, dollars =	1.1439e8

7. Material and Equipment:

M = 25.672*(A)^0.689*(S)^0.624*(Q)^0.792 (24-7)

Development:

M, dollars = 4670839.

Production:

M, dollars = 2.6520e8

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8. Engine and Avionics:

Engines: Unit cost, dollars = 1523022
Total Cost = Unit cost * N Engines * Q

Development:

Cost, dollars = 9138132

Production:

Cost, dollars = 1.5230e9

Avionics = cost per aircraft * Q

Development:

Cost, dollars = 2250000

Production:

Cost, dollars = 3.75e8

9. Total DT&E Cost:

Airframe Engineering		46994268
Development Support		10437266
Flight Test Aircraft		1.6735e8
Engines & Avionics	11388132	
Man. Labor	64497531	
Material & Equipment	4670839.	
Tooling	78409740	
Quality Control	8384679.	
Flight Test Operations		2736403.
Test Facilities		0
Subtotal		2.2752e8
Profit (10% of subtotal)		22751886
Total DT&E Cost		2.5027e8

10. Total Production Cost:

Engine & Avionics	1.8980e9
Manufacturing Labor	8.7990e8
Material & Equipment	2.6520e8
Sustaining Engineering	72988435
Tooling	1.1672e8
Quality Control	1.1439e8
Manufacturing Facilities	0
Subtotal	3.3472e9

Profit (10% of subtotal)	3.3472e8
Total Production Cost	3.6819e9

11. Unit Cost:

Amortization of RDT&E Cost over first four years:

Units = # Years * R * 12 =	192
Cost =	2.5027e8
Cost/Unit =	1303493.

Cost per Production Unit:

Cost =	3.6819e9
Units =	500
Cost/ Unit =	7363869.

Unit cost for first 192 airplanes =	8667362.
Unit cost for further production units =	7363869.

B2. COST ANALYSIS FOR NASA COMMUTER FAMILY: 36 PAX

Development and Production Costs

Input:	Time =	1987
	Empty Weight (lbs) =	20177
	AMPR/Empty Weight =	.66
	AMPR Weight, A (lbs) =	13316.82
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4
	Flight Test Rate =	1
	Total Production, Q D + Q P =	503
	Engine =	1523022
	Avionics =	750000
	Engineering Dollar Rate =	65
	Cost Escalation Factor =	3
	Manufacturing Dollar Rate =	50
	Tooling Dollar Rate =	55

1. Engineering Hours:

E = 0.0396*(A)^0.791*(S)^1.526*(Q)^0.183 (24-1)

Development:

D, (hours) =	866447.7
Rate =	65
Cost, dollars =	56319100

Production:

E, (hours) =	1345710.
Rate =	65
Cost, dollars =	87471156

2. Development support:

D = 0.008325*(A)^0.873*(S)^1.89*(Q D)^0.346 (24-2)

D, dollars = 12745206

3. Flight Test Operations:

F = 0.001244*(A)^1.16*(S)^1.371*(Q D)^1.281 (24-3)

F, dollars = 3568311.

4. Tooling:

T = 4.0127*(A)^0.764*(S)^0.899*(Q)^0.178*(R)^0.066 (24-4)

Development:

T, hours =	1697989.
Rate =	55
Cost, dollars=	93389387

Production:

T, hours =	2527591.
Rate =	55
Cost, dollars =	1.3902e8

5. Manufacturing Labor:

L = 28.98d*(A)^0.74*(S)^0.543*(Q)^0.524 (24-5)

Development:

L, hours =	1527972.
Rate =	50
Cost, dollars =	76398608

Production:

L, hours =	20845095
Rate =	50
Cost, dollars =	1.0423e9

6. Quality Control:

Q/C = 0.13*L (24-6)

Development:

Q/C, hours =	198636.4
Rate =	50
Cost, dollars =	9931819.

Production:

Q/C, hours =	2709862.
Rate =	50
Cost, dollars =	1.3549e8

7. Material and Equipment:

M = 25.672*(A)^0.689*(S)^0.624*(Q)^0.792 (24-7)

Development:

M, dollars = 5468508.

Production:

M, dollars = 3.1049e8

8. Engine and Avionics:

Engines: Unit cost, dollars = 1523022
Total Cost = Unit cost * N Engines * Q

Development:

Cost, dollars = 9138132

Production:

Cost, dollars = 1.5230e9

Avionics = cost per aircraft * Q

Development:

Cost, dollars = 2250000

Production:

Cost, dollars = 3.75e8

9. Total DT&E Cost:

Airframe Engineering		56319100
Development Support		12745206
Flight Test Aircraft		1.9658e8
Engines & Avionics	11388132	
Man. Labor	76398608	
Material & Equipment	5468508.	
Tooling	93389387	
Quality Control	9931819.	
Flight Test Operations		3568311.
Test Facilities		0
Subtotal		2.6921e8
Profit (10% of subtotal)		26920907
Total DT&E Cost		2.9613e8

10. Total Production Cost:

Engine & Avionics	1.8980e9
Manufacturing Labor	1.0423e9
Material & Equipment	3.1049e8
Sustaining Engineering	87471156
Tooling	1.3902e8
Quality Control	1.3549e8
Manufacturing Facilities	0
Subtotal	3.6127e9

Profit (10% of subtotal)	3.6127e8
Total Production Cost	3.9740e9

11. Unit Cost:

Amortization of RDT&E Cost over first four years:

Units = # Years * R * 12 =	192
Cost =	2.9613e8
Cost/Unit =	1542344.

Cost per Production Unit:

Cost =	3.9740e9
Units =	500
Cost/ Unit =	7948048.

Unit cost for first 192 airplanes =	9490391.
Unit cost for further production units =	7948048.

B3. COST ANALYSIS FOR NASA COMMUTER FAMILY: 50 PAX

Development and Production Costs

Input:	Time =	1987
	Empty Weight (lbs) =	25153
	AMPR/Empty Weight =	.66
	AMPR Weight, A (lbs) =	16600.98
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4
	Flight Test Rate =	1
	Total Production, Q D + Q P =	503
	Engine =	1523022
	Avionics =	750000
	Engineering Dollar Rate =	65
	Cost Escalation Factor =	3
	Manufacturing Dollar Rate =	50
	Tooling Dollar Rate =	55

1. Engineering Hours:

E = 0.0396*(A)^0.791*(S)^1.526*(Q)^0.183 (24-1)

Development:

D, (hours) =	1031495.
Rate =	65
Cost, dollars =	67047202

Production:

E, (hours) =	1602051.
Rate =	65
Cost, dollars =	1.0413e8

2. Development support:

D = 0.008325*(A)^0.873*(S)^1.89*(Q D)^0.346 (24-2)

D, dollars = 15449767

3. Flight Test Operations:

F = 0.001244*(A)^1.16*(S)^1.371*(Q D)^1.281 (24-3)

F, dollars = 4608007.

4. Tooling:

T = 4.0127*(A)^0.764*(S)^0.899*(Q)^0.178*(R)^0.066 (24-4)

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Development:

T, hours =	2009440.
Rate =	55
Cost, dollars=	1.1052e8

Production:

T, hours =	2991211.
Rate =	55
Cost, dollars =	1.6452e8

5. Manufacturing Labor:

L = 28.984*(A)^0.74*(S)^0.543*(Q)^0.524 (24-5)

Development:

L, hours =	1798697.
Rate =	50
Cost, dollars =	89934849

Production:

L, hours =	24538411
Rate =	50
Cost, dollars =	1.2269e9

6. Quality Control:

Q/C = 0.13*L (24-6)

Development:

Q/C, hours =	233830.6
Rate =	50
Cost, dollars =	11691530

Production:

Q/C, hours =	3189993.
Rate =	50
Cost, dollars =	1.5950e8

7. Material and Equipment:

M = 25.672*(A)^0.689*(S)^0.624*(Q)^0.792 (24-7)

Development:

M, dollars = 6365448.

Production:

M, dollars = 3.6142e8

8. Engine and Avionics:

Engines: Unit cost, dollars = 1523022
Total Cost = Unit cost * N Engines * Q

Development:

Cost, dollars = 9138132

Production:

Cost, dollars = 1.5230e9

Avionics = cost per aircraft * Q

Development:

Cost, dollars = 2250000

Production:

Cost, dollars = 3.75e8

9. Total DT&E Cost:

Airframe Engineering		67047202
Development Support		15449767
Flight Test Aircraft		2.2990e8
Engines & Avionics	11388132	
Man. Labor	89934849	
Material & Equipment	6365448.	
Tooling	1.1052e8	
Quality Control	11691530	
Flight Test Operations		4608007.
Test Facilities		0
Subtotal		3.1700e8
Profit (10% of subtotal)		31700412
Total DT&E Cost		3.4870e8

10. Total Production Cost:

Engine & Avionics	1.8980e9
Manufacturing Labor	1.2269e9
Material & Equipment	3.6142e8
Sustaining Engineering	1.0413e8
Tooling	1.6452e8
Quality Control	1.5950e8
Manufacturing Facilities	0
Subtotal	3.9145e9

Profit (10% of subtotal)	3.9145e8
Total Production Cost	4.3060e9

11. Unit Cost:

Amortization of RDT&E Cost over first four years:

Units = # Years * R * 12 =	192
Cost =	3.4870e8
Cost/Unit =	1816169.

Cost per Production Unit:

Cost =	4.3060e9
Units =	500
Cost/ Unit =	8611920.

Unit cost for first 192 airplanes =	10428089
Unit cost for further production units =	8611920.

B4. COST ANALYSIS FOR NASA COMMUTER FAMILY: 75 PAX

Development and Production Costs

Input:	Time =	1987
	Empty Weight (lbs) =	40024
	AMPR/Empty Weight =	.66
	AMPR Weight, A (lbs) =	26415.84
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4
	Flight Test Rate =	1
	Total Production, Q D + Q P =	503
	Engine =	2727733
	Avionics =	750000
	Engineering Dollar Rate =	65
	Cost Escalation Factor =	3
	Manufacturing Dollar Rate =	50
	Tooling Dollar Rate =	55

1. Engineering Hours:

E = 0.0396*(A)^0.791*(S)^1.526*(Q)^0.183 (24-1)

Development:

D, (hours) = 1489486.
Rate = 65
Cost, dollars = 96816559

Production:

E, (hours) = 2313372.
Rate = 65
Cost, dollars = 1.5037e8

2. Development support:

D = 0.008325*(A)^0.873*(S)^1.89*(Q D)^0.346 (24-2)

D, dollars = 23175699

3. Flight Test Operations:

F = 0.001244*(A)^1.16*(S)^1.371*(Q D)^1.281 (24-3)

F, dollars = 7898066.

4. Tooling:

T = 4.0127*(A)^0.764*(S)^0.899*(Q)^0.178*(R)^0.066 (24-4)

Development:

T, hours =	2865479.
Rate =	55
Cost, dollars=	1.5760e8

Production:

T, hours =	4265494.
Rate =	55
Cost, dollars =	2.3460e8

5. Manufacturing Labor:

L = 28.984*(A)^0.74*(S)^0.543*(Q)^0.524 (24-5)

Development:

L, hours =	2536523.
Rate =	50
Cost, dollars =	1.2683e8

Production:

L, hours =	34604068
Rate =	50
Cost, dollars =	1.7302e9

6. Quality Control:

Q/C = 0.13*L (24-6)

Development:

Q/C, hours =	329747.9
Rate =	50
Cost, dollars =	16487396

Production:

Q/C, hours =	4498529.
Rate =	50
Cost, dollars =	2.2493e8

7. Material and Equipment:

M = 25.672*(A)^0.689*(S)^0.624*(Q)^0.792 (24-7)

Development:

M, dollars =	8766403.

Production:

M, dollars =	4.9774e8

8. Engine and Avionics:

Engines: Unit cost, dollars = 2727733
Total Cost = Unit cost * N Engines * Q

Development:

Cost, dollars = 16366398

Production:

Cost, dollars = 2.7277e9

Avionics = cost per aircraft * Q

Development:

Cost, dollars = 2250000

Production:

Cost, dollars = 3.75e8

9. Total DT&E Cost:

Airframe Engineering		96816559
Development Support		23175699
Flight Test Aircraft		3.2830e8
Engines & Avionics	18616398	
Man. Labor	1.2683e8	
Material & Equipment	8766403.	
Tooling	1.5760e8	
Quality Control	16487396	
Flight Test Operations		7898066.
Test Facilities		0
Subtotal		4.5619e8
Profit (10% of subtotal)		45618800
Total DT&E Cost		5.0181e8

10. Total Production Cost:

Engine & Avionics	3.1027e9
Manufacturing Labor	1.7302e9
Material & Equipment	4.9774e8
Sustaining Engineering	1.5037e8
Tooling	2.3460e8
Quality Control	2.2493e8
Manufacturing Facilities	0
Subtotal	5.9406e9

Profit (10% of subtotal)	5.9406e8
Total Production Cost	6.5346e9

11. Unit Cost:

Amortization of RDT&E Cost over first four years:

Units = # Years * R * 12 =	192
Cost =	5.0181e8
Cost/Unit =	2613577.

Cost per Production Unit:

Cost =	6.5346e9
Units =	500
Cost/ Unit =	13069259

Unit cost for first 192 airplanes =	15682836
Unit cost for further production units =	13069259

B5. COST ANALYSIS FOR NASA COMMUTER FAMILY: 100 PAX

Development and Production Costs

Input:	Time =	1987
	Empty Weight (lbs) =	49071
	AMPR/Empty Weight =	.66
	AMPR Weight, A (lbs) =	32386.86
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4
	Flight Test Rate =	1
	Total Production, Q D + Q P =	503
	Engine =	2727733
	Avionics =	750000
	Engineering Dollar Rate =	65
	Cost Escalation Factor =	3
	Manufacturing Dollar Rate =	50
	Tooling Dollar Rate =	55

1. Engineering Hours:

E = 0.0396*(A)^0.791*(S)^1.526*(Q)^0.183 (24-1)

Development:

D, (hours) =	1750021.
Rate =	65
Cost, dollars =	1.1375e8

Production:

E, (hours) =	2718019.
Rate =	65
Cost, dollars =	1.7667e8

2. Development support:

D = 0.008325*(A)^0.873*(S)^1.89*(Q D)^0.346 (24-2)

D, dollars = 27688357

3. Flight Test Operations:

F = 0.001244*(A)^1.16*(S)^1.371*(Q D)^1.281 (24-3)

F, dollars = 10004282

4. Tooling:

T = 4.0127*(A)^0.764*(S)^0.899*(Q)^0.178*(R)^0.066 (24-4)

Development:

```
T, hours =              3348225.
Rate =                        55
Cost, dollars=          1.8415e8
```

Production:

```
T, hours =              4984099.
Rate =                        55
Cost, dollars =         2.7413e8
```

5. Manufacturing Labor:

$$L = 28.984*(A)^{0.74}*(S)^{0.543}*(Q)^{0.524} \qquad (24\text{-}5)$$

Development:

```
L, hours =              2949389.
Rate =                        50
Cost, dollars =         1.4747e8
```

Production:

```
L, hours =              40236522
Rate =                        50
Cost, dollars =         2.0118e9
```

6. Quality Control:

$$Q/C = 0.13*L \qquad (24\text{-}6)$$

Development:

```
Q/C, hours =            383420.5
Rate =                        50
Cost, dollars =         19171026
```

Production:

```
Q/C, hours =            5230748.
Rate =                        50
Cost, dollars =         2.6154e8
```

7. Material and Equipment:

$$M = 25.672*(A)^{0.689}*(S)^{0.624}*(Q)^{0.792} \qquad (24\text{-}7)$$

Development:

```
M, dollars =            10087905
```

Production:

```
M, dollars =            5.7277e8
```

8. Engine and Avionics:

Engines: Unit cost, dollars = 2727733
Total Cost = Unit cost * N Engines * Q

Development:

Cost, dollars = 16366398

Production:

Cost, dollars = 2.7277e9

Avionics = cost per aircraft * Q

Development:

Cost, dollars = 2250000

Production:

Cost, dollars = 3.75e8

9. Total DT&E Cost:

Airframe Engineering		1.1375e8
Development Support		27688357
Flight Test Aircraft		3.7950e8
Engines & Avionics	18616398	
Man. Labor	1.4747e8	
Material & Equipment	10087905	
Tooling	1.8415e8	
Quality Control	19171026	
Flight Test Operations		10004282
Test Facilities		0
Subtotal		5.3094e8
Profit (10% of subtotal)		53094114
Total DT&E Cost		5.8404e8

10. Total Production Cost:

Engine & Avionics	3.1027e9
Manufacturing Labor	2.0118e9
Material & Equipment	5.7277e8
Sustaining Engineering	1.7667e8
Tooling	2.7413e8
Quality Control	2.6154e8
Manufacturing Facilities	0
Subtotal	6.3997e9

Profit (10% of subtotal)	6.3997e8
Total Production Cost	7.0396e9

11. Unit Cost:

Amortization of RDT&E Cost over first four years:

Units = # Years * R * 12 =	192
Cost =	5.8404e8
Cost/Unit =	3041850.

Cost per Production Unit:

Cost =	7.0396e9
Units =	500
Cost/ Unit =	14079259

Unit cost for first 192 airplanes =	17121109
Unit cost for further production units =	14079259

B6. COST ANALYSIS FOR NASA COMMUTER FAMILY: 75 PAX SINGLE-BODY

Development and Production Costs

Input:	Time =	1987
	Empty Weight (lbs) =	48175
	AMPR/Empty Weight =	.66
	AMPR Weight, A (lbs) =	31795.5
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4
	Flight Test Rate =	1
	Total Production, Q D + Q P =	503
	Engine =	2727733
	Avionics =	750000
	Engineering Dollar Rate =	65
	Cost Escalation Factor =	3
	Manufacturing Dollar Rate =	50
	Tooling Dollar Rate =	55

1. Engineering Hours:

E = 0.0396*(A)^0.791*(S)^1.526*(Q)^0.183 (24-1)

Development:

D, (hours) =	1724697.
Rate =	65
Cost, dollars =	1.1211e8

Production:

E, (hours) =	2678687.
Rate =	65
Cost, dollars =	1.7411e8

2. Development support:

D = 0.008325*(A)^0.873*(S)^1.89*(Q D)^0.346 (24-2)

D, dollars = 27246480

3. Flight Test Operations:

F = 0.001244*(A)^1.16*(S)^1.371*(Q D)^1.281 (24-3)

F, dollars = 9792695.

4. Tooling:

T = 4.0127*(A)^0.764*(S)^0.899*(Q)^0.178*(R)^0.066 (24-4)

Development:

T, hours =	3301416.
Rate =	55
Cost, dollars=	1.8158e8

Production:

T, hours =	4914420.
Rate =	55
Cost, dollars =	2.7029e8

5. Manufacturing Labor:

L = 28.984*(A)^0.74*(S)^0.543*(Q)^0.524 (24-5)

Development:

L, hours =	2909442.
Rate =	50
Cost, dollars =	1.4547e8

Production:

L, hours =	39691551
Rate =	50
Cost, dollars =	1.9846e9

6. Quality Control:

Q/C = 0.13*L (24-6)

Development:

Q/C, hours =	378227.4
Rate =	50
Cost, dollars =	18911370

Production:

Q/C, hours =	5159902.
Rate =	50
Cost, dollars =	2.5800e8

7. Material and Equipment:

M = 25.672*(A)^0.689*(S)^0.624*(Q)^0.792 (24-7)

Development:

M, dollars = 9960630.

Production:

M, dollars = 5.655e8

8. Engine and Avionics:

Engines: Unit cost, dollars = 2727733
Total Cost = Unit cost * N Engines * Q

Development:

Cost, dollars = 16366398

Production:

Cost, dollars = 2.7277e9

Avionics = cost per aircraft * Q

Development:

Cost, dollars = 2250000

Production:

Cost, dollars = 3.75e8

9. Total DT&E Cost:

Airframe Engineering		1.1211e8
Development Support		27246480
Flight Test Aircraft		3.7454e8
Engines & Avionics	18616398	
Man. Labor	1.4547e8	
Material & Equipment	9960630.	
Tooling	1.8158e8	
Quality Control	18911370	
Flight Test Operations		9792695.
Test Facilities		0
Subtotal		5.2368e8
Profit (10% of subtotal)		52368280
Total DT&E Cost		5.7605e8

10. Total Production Cost:

Engine & Avionics	3.1027e9
Manufacturing Labor	1.9846e9
Material & Equipment	5.6554e8
Sustaining Engineering	1.7411e8
Tooling	2.7029e8
Quality Control	2.5800e8
Manufacturing Facilities	0
Subtotal	6.3553e9

Profit (10% of subtotal)	6.3555e8
Total Production Cost	6.9908e9

11. Unit Cost:

Amortization of RDT&E Cost over first four years:

Units = # Years * R * 12 =	192
Cost =	5.7605e8
Cost/Unit =	3000266.

Cost per Production Unit:

Cost =	6.9908e9
Units =	500
Cost/ Unit =	13981566

Unit cost for first 192 airplanes =	16981832
Unit cost for further production units =	13981566

B7. COST ANALYSIS FOR NASA COMMUTER FAMILY: 100 PAX SINGLE-BODY

Development and Production Costs

Input:	Time =	1987
	Empty Weight (lbs) =	66041
	AMPR/Empty Weight =	.66
	AMPR Weight, A (lbs) =	43587.06
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4
	Flight Test Rate =	. 1
	Total Production, Q D + Q P =	503
	Engine =	2727733
	Avionics =	750000
	Engineering Dollar Rate =	65
	Cost Escalation Factor =	3
	Manufacturing Dollar Rate =	50
	Tooling Dollar Rate =	55

1. Engineering Hours:

$$E = 0.0396*(A)^{0.791}*(S)^{1.526}*(Q)^{0.183} \qquad (24-1)$$

Development:

D, (hours) =	2213469.
Rate =	65
Cost, dollars =	1.4388e8

Production:

E, (hours) =	3437815.
Rate =	65
Cost, dollars =	2.2346e8

2. Development support:

$$D = 0.008325*(A)^{0.873}*(S)^{1.89}*(Q\ D)^{0.346} \qquad (24-2)$$

D, dollars = 35884290

3. Flight Test Operations:

$$F = 0.001244*(A)^{1.16}*(S)^{1.371}*(Q\ D)^{1.281} \qquad (24-3)$$

F, dollars = 14119289

4. Tooling:

$$T = 4.0127*(A)^{0.764}*(S)^{0.899}*(Q)^{0.178}*(R)^{0.066} \qquad (24-4)$$

Development:

T, hours =	4201090.
Rate =	55
Cost, dollars=	2.3106e8

Production:

T, hours =	6253657.
Rate =	55
Cost, dollars =	3.4395e8

5. Manufacturing Labor:

L = 28.984*(A)^0.74*(S)^0.543*(Q)^0.524 (24-5)

Development:

L, hours =	3674376.
Rate =	50
Cost, dollars =	1.8372e8

Production:

L, hours =	50127044
Rate =	50
Cost, dollars =	2.5064e9

6. Quality Control:

Q/C = 0.13*L (24-6)

Development:

Q/C, hours =	477668.9
Rate =	50
Cost, dollars =	23883447

Production:

Q/C, hours =	6516516.
Rate =	50
Cost, dollars =	3.2583e8

7. Material and Equipment:

M = 25.672*(A)^0.689*(S)^0.624*(Q)^0.792 (24-7)

Development:

M, dollars =	12378677

Production:

M, dollars =	7.0284e8

8. Engine and Avionics:

Engines: Unit cost, dollars = 2727733
Total Cost = Unit cost * N Engines * Q

Development:

Cost, dollars = 16366398

Production:

Cost, dollars = 2.7277e9

Avionics = cost per aircraft * Q

Development:

Cost, dollars = 2250000

Production:

Cost, dollars = 3.75e8

9. Total DT&E Cost:

Airframe Engineering		1.4388e8
Development Support		35884290
Flight Test Aircraft		4.6966e8
Engines & Avionics	18616398	
Man. Labor	1.8372e8	
Material & Equipment	12378677	
Tooling	2.3106e8	
Quality Control	23883447	
Flight Test Operations		14119289
Test Facilities		0
Subtotal		6.6354e8
Profit (10% of subtotal)		66353635
Total DT&E Cost		7.2989e8

10. Total Production Cost:

Engine & Avionics	3.1027e9
Manufacturing Labor	2.5064e9
Material & Equipment	7.0284e8
Sustaining Engineering	2.2346e8
Tooling	3.4395e8
Quality Control	3.2583e8
Manufacturing Facilities	0
Subtotal	7.2052e9

Profit (10% of subtotal)	7.2052e8
Total Production Cost	7.9257e9

11. Unit Cost:

Amortization of RDT&E Cost over first four years:

Units = # Years * R * 12 =	192
Cost =	7.2989e8
Cost/Unit =	3801510.

Cost per Production Unit:

Cost =	7.9257e9
Units =	500
Cost/ Unit =	15851342

Unit cost for first 192 airplanes =	19652852
Unit cost for further production units =	15851342

APPENDIX C: CALCULATIONS OF COMMONALITY EFFECTS ON ACQUISITION COSTS.

The purpose of this appendix is to show the input parameters and output cost breakdowns for commonality versus baseline costs. The same spreadsheet was used for these calculations as was used to calculate the baseline costs in Appendix B.

Class II weight breakdowns from Ref. 2 were used as the input for the various airplane components. The baseline component weights were used to find the original cost contribution of those components. The commonality was accounted for by then using commonalized weight breakdowns and the increased production quantities. The comparison between the two costs is presented and discussed in Chapter 3.

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C1.1. COST ANALYSIS FOR NASA COMMUTER FAMILY: Nose Gear
No Commonality Implemented/25 Pax.
Development and Production Costs

Input:	Time =	1987
	Empty Weight (lbs) =	16050
	AMPR Weight, A (lbs) =	201
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4

9. Total DT&E Cost:

Airframe Engineering		2042128.
Development Support		327669.0
Flight Test Aircraft		19361308
Engines & Avionics	11388132	
Man. Labor	3430790.	
Material & Equipment	304129.8	
Tooling	3792253.	
Quality Control	446002.7	
Flight Test Operations		27533.76
Test Facilities		0
Subtotal		21758638
Profit (10% of subtotal)		2175864.
Total DT&E Cost		23934502

10. Total Production Cost:

Engine & Avionics	1.8980e9
Manufacturing Labor	46803957
Material & Equipment	17267852
Sustaining Engineering	3171700.
Tooling	5645070.
Quality Control	6084514.
Manufacturing Facilities	0
Subtotal	1.9770e9
Profit (10% of subtotal)	1.9770e8
Total Production Cost	2.1747e9

C1.2. COST ANALYSIS FOR NASA COMMUTER FAMILY: Nose Gear
No Commonality Implemented/36 Pax.
Development and Production Costs

Input:	Time =	1987
	Empty Weight (lbs) =	20177
	AMPR Weight, A (lbs) =	267
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4

9. Total DT&E Cost:

Airframe Engineering		2556379.
Development Support		419845.5
Flight Test Aircraft		21252228
Engines & Avionics	11388132	
Man. Labor	4232991.	
Material & Equipment	369847.9	
Tooling	4710968.	
Quality Control	550288.9	
Flight Test Operations		38274.64
Test Facilities		0
Subtotal		24266727
Profit (10% of subtotal)		2426673.
Total DT&E Cost		26693400

10. Total Production Cost:

Engine & Avionics	1.8980e9
Manufacturing Labor	57747851
Material & Equipment	20999188
Sustaining Engineering	3970402.
Tooling	7012650.
Quality Control	7507221.
Manufacturing Facilities	0
Subtotal	1.9953e9
Profit (10% of subtotal)	1.9953e8
Total Production Cost	2.1948e9

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C1.3. COST ANALYSIS FOR NASA COMMUTER FAMILY: Nose Gear
No Commonality Implemented/50 Pax.
Development and Production Costs

Input:	Time =	1987
	Empty Weight (lbs) =	25153
	AMPR Weight, A (lbs) =	331
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4

9. Total DT&E Cost:

Airframe Engineering		3029973.
Development Support		506471.5
Flight Test Aircraft		22976056
Engines & Avionics	11388132	
Man. Labor	4962514.	
Material & Equipment	428862.8	
Tooling	5551420.	
Quality Control	645126.9	
Flight Test Operations		49108.71
Test Facilities		0
Subtotal		26561610
Profit (10% of subtotal)		2656161.
Total DT&E Cost		29217771

10. Total Production Cost:

Engine & Avionics	1.8980e9
Manufacturing Labor	67700240
Material & Equipment	24349931
Sustaining Engineering	4705957.
Tooling	8263730.
Quality Control	8801031.
Manufacturing Facilities	0
Subtotal	2.0118e9
Profit (10% of subtotal)	2.0118e8
Total Production Cost	2.2130e9

C1.4. COST ANALYSIS FOR NASA COMMUTER FAMILY: Nose Gear
No Commonality Implemented/75 Pax.
Development and Production Costs

Input:	Time =	1987
	Empty Weight (lbs) =	40024
	AMPR Weight, A (lbs) =	437
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4

9. Total DT&E Cost:

Airframe Engineering		3774641.
Development Support		645484.0
Flight Test Aircraft		25659098
Engines & Avionics	11388132	
Man. Labor	6095163.	
Material & Equipment	519336.2	
Tooling	6864096.	
Quality Control	792371.2	
Flight Test Operations		67782.33
Test Facilities		0
Subtotal		30147006
Profit (10% of subtotal)		3014701.
Total DT&E Cost		33161706

10. Total Production Cost:

Engine & Avionics	1.8980e9
Manufacturing Labor	83152202
Material & Equipment	29486821
Sustaining Engineering	5862527.
Tooling	10217752
Quality Control	10809786
Manufacturing Facilities	0
Subtotal	2.0376e9
Profit (10% of subtotal)	2.0376e8
Total Production Cost	2.2413e9

C1.5. COST ANALYSIS FOR NASA COMMUTER FAMILY: Nose Gear
No Commonality Implemented/100 Pax.

Development and Production Costs

Input:	Time =	1987
	Empty Weight (lbs) =	49071
	AMPR Weight, A (lbs) =	499
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4

9. Total DT&E Cost:

Airframe Engineering		4192301.
Development Support		724747.9
Flight Test Aircraft		27151564
Engines & Avionics	11388132	
Man. Labor	6723934.	
Material & Equipment	569047.0	
Tooling	7596339.	
Quality Control	874111.4	
Flight Test Operations		79059.61
Test Facilities		0
Subtotal		32147672
Profit (10% of subtotal)		3214767.
Total DT&E Cost		35362439

10. Total Production Cost:

Engine & Avionics	1.8980e9
Manufacturing Labor	91730106
Material & Equipment	32309298
Sustaining Engineering	6511208.
Tooling	11307754
Quality Control	11924914
Manufacturing Facilities	0
Subtotal	2.0518e9
Profit (10% of subtotal)	2.0518e8
Total Production Cost	2.2570e9

C1.6. COST ANALYSIS FOR NASA COMMUTER FAMILY: Nose Gear Commonality Implemented/All Sizes.

Development and Production Costs

Input:	Time =	1987
	AMPR Weight, A (lbs) =	331
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	7
	Production Quantity, Q P =	3500
	Production Rate (planes per month) =	28

9. Total DT&E Cost:

Airframe Engineering		3538169.
Development Support		679008.2
Flight Test Aircraft		43492816
Engines & Avionics	26572308	
Man. Labor	7736092.	
Material & Equipment	838988.4	
Tooling	7339736.	
Quality Control	1005692.	
Flight Test Operations		145390.8
Test Facilities		0
Subtotal		47855384
Profit (10% of subtotal)		4785538.
Total DT&E Cost		52640922

10. Total Production Cost:

Engine & Avionics	1.329e10
Manufacturing Labor	1.9328e8
Material & Equipment	1.1451e8
Sustaining Engineering	7498776.
Tooling	14855081
Quality Control	25126746
Manufacturing Facilities	0
Subtotal	1.364e10
Profit (10% of subtotal)	1.3641e9
Total Production Cost	1.501e10

C2.1. COST ANALYSIS FOR NASA COMMUTER FAMILY: Main Gear
No Commonality Implemented/25 Pax.
Development and Production Costs

Input:	Time =	1987
	Empty Weight (lbs) =	16050
	AMPR Weight, A (lbs) =	765
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4

9. Total DT&E Cost:

Airframe Engineering		5878020.
Development Support		1052402.
Flight Test Aircraft		33104202
Engines & Avionics	11388132	
Man. Labor	9224408.	
Material & Equipment	763835.1	
Tooling	10528654	
Quality Control	1199173.	
Flight Test Operations		129779.3
Test Facilities		0
Subtotal		40164404
Profit (10% of subtotal)		4016440.
Total DT&E Cost		44180844

10. Total Production Cost:

Engine & Avionics	1.8980e9
Manufacturing Labor	1.2584e8
Material & Equipment	43368956
Sustaining Engineering	9129358.
Tooling	15672739
Quality Control	16359510
Manufacturing Facilities	0
Subtotal	2.1084e9
Profit (10% of subtotal)	2.1084e8
Total Production Cost	2.3192e9

C2.2. COST ANALYSIS FOR NASA COMMUTER FAMILY: Main Gear
No Commonality Implemented/36 Pax.
Development and Production Costs

Input:	Time =	1987
	Empty Weight (lbs) =	20177
	AMPR Weight, A (lbs) =	1097
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4

9. Total DT&E Cost:

Airframe Engineering		7817328.
Development Support		1441603.
Flight Test Aircraft		39844084
Engines & Avionics	11388132	
Man. Labor	12044311	
Material & Equipment	979172.5	
Tooling	13866708	
Quality Control	1565760.	
Flight Test Operations		197150.4
Test Facilities		0
Subtotal		49300165
Profit (10% of subtotal)		4930017.
Total DT&E Cost		54230182

10. Total Production Cost:

Engine & Avionics	1.8980e9
Manufacturing Labor	1.6431e8
Material & Equipment	55595368
Sustaining Engineering	12141364
Tooling	20641698
Quality Control	21360615
Manufacturing Facilities	0
Subtotal	2.1721e9
Profit (10% of subtotal)	2.1721e8
Total Production Cost	2.3893e9

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C2.3. COST ANALYSIS FOR NASA COMMUTER FAMILY: Main Gear
No Commonality Implemented/50 Pax.
Development and Production Costs

Input:	Time =	1987
	Empty Weight (lbs) =	25153
	AMPR Weight, A (lbs) =	1438
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4

9. Total DT&E Cost:

Airframe Engineering		9683719.
Development Support		1825865.
Flight Test Aircraft		46248713
Engines & Avionics	11388132	
Man. Labor	14715351	
Material & Equipment	1179920.	
Tooling	17052314	
Quality Control	1912996.	
Flight Test Operations		269872.3
Test Facilities		0
Subtotal		58028169
Profit (10% of subtotal)		5802817.
Total DT&E Cost		63830986

10. Total Production Cost:

Engine & Avionics	1.8980e9
Manufacturing Labor	2.0075e8
Material & Equipment	66993414
Sustaining Engineering	15040121
Tooling	25383724
Quality Control	26097711
Manufacturing Facilities	0
Subtotal	2.2323e9
Profit (10% of subtotal)	2.2323e8
Total Production Cost	2.4555e9

C2.4. COST ANALYSIS FOR NASA COMMUTER FAMILY: Main Gear
No Commonality Implemented/75 Pax.
Development and Production Costs

Input:	Time =	1987
	Empty Weight (lbs) =	40024
	AMPR Weight, A (lbs) =	2036
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4

9. Total DT&E Cost:

Airframe Engineering		12749645
Development Support		2473479.
Flight Test Aircraft		63865284
Engines & Avionics	18616398	
Man. Labor	19033761	
Material & Equipment	1499356.	
Tooling	22241381	
Quality Control	2474389.	
Flight Test Operations		403961.8
Test Facilities		0
Subtotal		79492370
Profit (10% of subtotal)		7949237.
Total DT&E Cost		87441607

10. Total Production Cost:

Engine & Avionics	3.1027e9
Manufacturing Labor	2.5966e8
Material & Equipment	85130292
Sustaining Engineering	19801918
Tooling	33108063
Quality Control	33756421
Manufacturing Facilities	0
Subtotal	3.5342e9
Profit (10% of subtotal)	3.5342e8
Total Production Cost	3.8876e9

C2.5. COST ANALYSIS FOR NASA COMMUTER FAMILY: Main Gear
No Commonality Implemented/100 Pax.
Development and Production Costs

Input:	Time =	1987
	Empty Weight (lbs) =	49071
	AMPR Weight, A (lbs) =	2684
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4

9. Total DT&E Cost:

Airframe Engineering		15864334
Development Support		3148273.
Flight Test Aircraft		74287356
Engines & Avionics	18616398	
Man. Labor	23352217	
Material & Equipment	1813794.	
Tooling	27469159	
Quality Control	3035788.	
Flight Test Operations		556603.3
Test Facilities		0
Subtotal		93856566
Profit (10% of subtotal)		9385657.
Total DT&E Cost		1.0324e8

10. Total Production Cost:

Engine & Avionics	3.1027e9
Manufacturing Labor	3.1858e8
Material & Equipment	1.0298e8
Sustaining Engineering	24639450
Tooling	40890026
Quality Control	41415213
Manufacturing Facilities	0
Subtotal	3.6312e9
Profit (10% of subtotal)	3.6312e8
Total Production Cost	3.9944e9

C2.6. COST ANALYSIS FOR NASA COMMUTER FAMILY: Main Gear Commonality Implemented/All Sizes.

Development and Production Costs

Input:	Time =	1987
	AMPR Weight, A (lbs) =	1438
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	7
	Production Quantity, Q P =	3500
	Production Rate (planes per month) =	28

9. Total DT&E Cost:

Airframe Engineering		11307899
Development Support		2447872.
Flight Test Aircraft		77348110
Engines & Avionics	26572308	
Man. Labor	22939844	
Material & Equipment	2308290.	
Tooling	22545488	
Quality Control	2982180.	
Flight Test Operations		798981.3
Test Facilities		0
Subtotal		91902862
Profit (10% of subtotal)		9190286.
Total DT&E Cost		1.0109e8

10. Total Production Cost:

Engine & Avionics	1.329e10
Manufacturing Labor	5.7314e8
Material & Equipment	3.1506e8
Sustaining Engineering	23965899
Tooling	45630393
Quality Control	74508377
Manufacturing Facilities	0
Subtotal	1.432e10
Profit (10% of subtotal)	1.4318e9
Total Production Cost	1.575e10

C3.1. COST ANALYSIS FOR NASA COMMUTER FAMILY:Horizontal Tail
No Commonality Implemented/25 Pax.
Development and Production Costs

Input:	Time =	1987
	Empty Weight (lbs) =	16050
	AMPR Weight, A (lbs) =	125
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4

9. Total DT&E Cost:

Airframe Engineering		1402525.
Development Support		216445.0
Flight Test Aircraft		16973350
Engines & Avionics	11388132	
Man. Labor	2414029.	
Material & Equipment	219244.1	
Tooling	2638121.	
Quality Control	313823.8	
Flight Test Operations		15869.88
Test Facilities		0
Subtotal		18608190
Profit (10% of subtotal)		1860819.
Total DT&E Cost		20469009

10. Total Production Cost:

Engine & Avionics	1.8980e9
Manufacturing Labor	32932970
Material & Equipment	12448220
Sustaining Engineering	2178311.
Tooling	3927053.
Quality Control	4281286.
Manufacturing Facilities	0
Subtotal	1.9538e9
Profit (10% of subtotal)	1.9538e8
Total Production Cost	2.1492e9

C3.2. COST ANALYSIS FOR NASA COMMUTER FAMILY:Horizontal Tail
No Commonality Implemented/36 Pax.

Development and Production Costs

Input:	Time =	1987
	Empty Weight (lbs) =	20177
	AMPR Weight, A (lbs) =	125
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4

9. Total DT&E Cost:

Airframe Engineering		1402525.
Development Support		216445.0
Flight Test Aircraft		16973350
Engines & Avionics	11388132	
Man. Labor	2414029.	
Material & Equipment	219244.1	
Tooling	2638121.	
Quality Control	313823.8	
Flight Test Operations		15869.88
Test Facilities		0
Subtotal		18608190
Profit (10% of subtotal)		1860819.
Total DT&E Cost		20469009

10. Total Production Cost:

Engine & Avionics	1.8980e9
Manufacturing Labor	32932970
Material & Equipment	12448220
Sustaining Engineering	2178311.
Tooling	3927053.
Quality Control	4281286.
Manufacturing Facilities	0
Subtotal	1.9538e9
Profit (10% of subtotal)	1.9538e8
Total Production Cost	2.1492e9

C3.3. COST ANALYSIS FOR NASA COMMUTER FAMILY:Horizontal Tail
No Commonality Implemented/50 Pax.

Development and Production Costs

Input:	Time =	1987
	Empty Weight (lbs) =	25153
	AMPR Weight, A (lbs) =	200
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4

9. Total DT&E Cost:

Airframe Engineering		2034087.
Development Support		326245.4
Flight Test Aircraft		19331559
Engines & Avionics	11388132	
Man. Labor	3418151.	
Material & Equipment	303086.5	
Tooling	3777830.	
Quality Control	444359.6	
Flight Test Operations		27374.92
Test Facilities		0
Subtotal		21719267
Profit (10% of subtotal)		2171927.
Total DT&E Cost		23891194

10. Total Production Cost:

Engine & Avionics	1.8980e9
Manufacturing Labor	46631532
Material & Equipment	17208615
Sustaining Engineering	3159212.
Tooling	5623601.
Quality Control	6062099.
Manufacturing Facilities	0
Subtotal	1.9767e9
Profit (10% of subtotal)	1.9767e8
Total Production Cost	2.1744e9

C3.4. COST ANALYSIS FOR NASA COMMUTER FAMILY:Horizontal Tail
No Commonality Implemented/75 Pax.
Development and Production Costs

Input:	Time =	1987
	Empty Weight (lbs) =	40024
	AMPR Weight, A (lbs) =	1027
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4

9. Total DT&E Cost:

Airframe Engineering		7420055.
Development Support		1360963.
Flight Test Aircraft		45699472
Engines & Avionics	18616398	
Man. Labor	11470733	
Material & Equipment	935683.3	
Tooling	13185462	
Quality Control	1491195.	
Flight Test Operations		182633.2
Test Facilities		0
Subtotal		54663122
Profit (10% of subtotal)		5466312.
Total DT&E Cost		60129434

10. Total Production Cost:

Engine & Avionics	3.1027e9
Manufacturing Labor	1.5649e8
Material & Equipment	53126142
Sustaining Engineering	11524345
Tooling	19627608
Quality Control	20343373
Manufacturing Facilities	0
Subtotal	3.3638e9
Profit (10% of subtotal)	3.3638e8
Total Production Cost	3.7002e9

C3.5. COST ANALYSIS FOR NASA COMMUTER FAMILY:Horizontal Tail
No Commonality Implemented/100 Pax.
Development and Production Costs

Input:	Time =	1987
	Empty Weight (lbs) =	49071
	AMPR Weight, A (lbs) =	1027
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4

9. Total DT&E Cost:

Airframe Engineering		7420055.
Development Support		1360963.
Flight Test Aircraft		45699472
Engines & Avionics	18616398	
Man. Labor	11470733	
Material & Equipment	935683.3	
Tooling	13185462	
Quality Control	1491195.	
Flight Test Operations		182633.2
Test Facilities		0
Subtotal		54663122
Profit (10% of subtotal)		5466312.
Total DT&E Cost		60129434

10. Total Production Cost:

Engine & Avionics	3.1027e9
Manufacturing Labor	1.5649e8
Material & Equipment	53126142
Sustaining Engineering	11524345
Tooling	19627608
Quality Control	20343373
Manufacturing Facilities	0
Subtotal	3.3638e9
Profit (10% of subtotal)	3.3638e8
Total Production Cost	3.7002e9

C3.6. COST ANALYSIS FOR NASA COMMUTER FAMILY:Horizontal Tail Commonality Implemented/All Sizes.

Development and Production Costs

Input:	Time =	1987
	AMPR Weight, A (lbs) =	200
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	5
	Production Quantity, Q P =	2500
	Production Rate (planes per month) =	20

9. Total DT&E Cost:

Airframe Engineering		2233407.
Development Support		389317.6
Flight Test Aircraft		29083554
Engines & Avionics	18980220	
Man. Labor	4467247.	
Material & Equipment	454224.7	
Tooling	4601120.	
Quality Control	580742.1	
Flight Test Operations		52667.30
Test Facilities		0
Subtotal		31758946
Profit (10% of subtotal)		3175895.
Total DT&E Cost		34934841

.10. Total Production Cost:

Engine & Avionics	9.4901e9
Manufacturing Labor	1.1161e8
Material & Equipment	61997180
Sustaining Engineering	4733471.
Tooling	9312324.
Quality Control	14509573
Manufacturing Facilities	0
Subtotal	9.6923e9
Profit (10% of subtotal)	9.6923e8
Total Production Cost	1.066e10

C3.7. COST ANALYSIS FOR NASA COMMUTER FAMILY:Horizontal Tail Commonality Implemented/75, 100 Pax.

Development and Production Costs

Input:	Time =	1987
	AMPR Weight, A (lbs) =	827
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	2
	Production Quantity, Q P =	1000
	Production Rate (planes per month) =	8

9. Total DT&E Cost:

Airframe Engineering		5804663.
Development Support		979038.8
Flight Test Aircraft		27988534
Engines & Avionics	7592088	
Man. Labor	7901532.	
Material & Equipment	584593.4	
Tooling	10883121	
Quality Control	1027199.	
Flight Test Operations		84506.78
Test Facilities		0
Subtotal		34856743
Profit (10% of subtotal)		3485674.
Total DT&E Cost		38342417

10. Total Production Cost:

Engine & Avionics	3.7960e9
Manufacturing Labor	1.9742e8
Material & Equipment	79791215
Sustaining Engineering	12302372
Tooling	22026629
Quality Control	25664095
Manufacturing Facilities	0
Subtotal	4.1332e9
Profit (10% of subtotal)	4.1332e8
Total Production Cost	4.5466e9

C4.1. COST ANALYSIS FOR NASA COMMUTER FAMILY: Vertical Tail.
No Commonality Implemented/25 Pax.

Development and Production Costs

Input:	Time =	1987
	Empty Weight (lbs) =	16050
	AMPR Weight, A (lbs) =	281
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4

9. Total DT&E Cost:

Airframe Engineering		2661838.
Development Support		439001.3
Flight Test Aircraft		21637421
Engines & Avionics	11388132	
Man. Labor	4396142.	
Material & Equipment	383103.0	
Tooling	4898546.	
Quality Control	571498.5	
Flight Test Operations		40612.28
Test Facilities		0
Subtotal		24778872
Profit (10% of subtotal)		2477887.
Total DT&E Cost		27256760

10. Total Production Cost:

Engine & Avionics	1.8980e9
Manufacturing Labor	59973607
Material & Equipment	21751785
Sustaining Engineering	4134193.
Tooling	7291874.
Quality Control	7796569.
Manufacturing Facilities	0
Subtotal	1.9990e9
Profit (10% of subtotal)	1.9990e8
Total Production Cost	2.1989e9

C4.2. COST ANALYSIS FOR NASA COMMUTER FAMILY: Vertical Tail
No Commonality Implemented/36 Pax.
Development and Production Costs

Input:	Time =	1987
	Empty Weight (lbs) =	20177
	AMPR Weight, A (lbs) =	307
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4

9. Total DT&E Cost:

Airframe Engineering		2854837.
Development Support		474260.5
Flight Test Aircraft		22340336
Engines & Avionics	11388132	
Man. Labor	4693658.	
Material & Equipment	407188.2	
Tooling	5241182.	
Quality Control	610175.6	
Flight Test Operations		45002.70
Test Facilities		0
Subtotal		25714436
Profit (10% of subtotal)		2571444.
Total DT&E Cost		28285880

10. Total Production Cost:

Engine & Avionics	1.8980e9
Manufacturing Labor	64032416
Material & Equipment	23119295
Sustaining Engineering	4433947.
Tooling	7801916.
Quality Control	8324214.
Manufacturing Facilities	0
Subtotal	2.0057e9
Profit (10% of subtotal)	2.0057e8
Total Production Cost	2.2063e9

C4.3. COST ANALYSIS FOR NASA COMMUTER FAMILY: Vertical Tail. No Commonality Implemented/50 Pax.

Development and Production Costs

Input:	Time =	1987
	Empty Weight (lbs) =	25153
	AMPR Weight, A (lbs) =	340
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4

9. Total DT&E Cost:

Airframe Engineering		3094958.
Development Support		518473.2
Flight Test Aircraft		23211449
Engines & Avionics	11388132	
Man. Labor	5062015.	
Material & Equipment	436863.6	
Tooling	5666376.	
Quality Control	658062.0	
Flight Test Operations		50660.98
Test Facilities		0
Subtotal		26875541
Profit (10% of subtotal)		2687554.
Total DT&E Cost		29563095

10. Total Production Cost:

Engine & Avionics	1.8980e9
Manufacturing Labor	69057665
Material & Equipment	24804199
Sustaining Engineering	4806887.
Tooling	8434852.
Quality Control	8977496.
Manufacturing Facilities	0
Subtotal	2.0141e9
Profit (10% of subtotal)	2.0141e8
Total Production Cost	2.2155e9

C4.4. COST ANALYSIS FOR NASA COMMUTER FAMILY: Vertical Tail. No Commonality Implemented/75 Pax.

Development and Production Costs

Input: Time =	1987
Empty Weight (lbs) =	40024
AMPR Weight, A (lbs) =	614
Maximum Speed, S (kts) =	412
Flight Test Quantity, Q D =	3
Production Quantity, Q P =	500
Production Rate (planes per month) =	4

9. Total DT&E Cost:

Airframe Engineering		4939649.
Development Support		868592.7
Flight Test Aircraft		37031724
Engines & Avionics	18616398	
Man. Labor	7839234.	
Material & Equipment	656454.9	
Tooling	8900536.	
Quality Control	1019100.	
Flight Test Operations		100561.9
Test Facilities		0
Subtotal		42940527
Profit (10% of subtotal)		4294053.
Total DT&E Cost		47234580

10. Total Production Cost:

Engine & Avionics	3.1027e9
Manufacturing Labor	1.0695e8
Material & Equipment	37272133
Sustaining Engineering	7671941.
Tooling	13249155
Quality Control	13902901
Manufacturing Facilities	0
Subtotal	3.2818e9
Profit (10% of subtotal)	3.2818e8
Total Production Cost	3.6100e9

Cd.5. COST ANALYSIS FOR NASA COMMUTER FAMILY: Vertical Tail. No Commonality Implemented/100 Pax.

Development and Production Costs

Input:	Time =	1987
	Empty Weight (lbs) =	49071
	AMPR Weight, A (lbs) =	680
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4

9. Total DT&E Cost:

Airframe Engineering		5355123.
Development Support		949566.7
Flight Test Aircraft		38496827
Engines & Avionics	18616398	
Man. Labor	8454456.	
Material & Equipment	704296.4	
Tooling	9622598.	
Quality Control	1099079.	
Flight Test Operations		113205.7
Test Facilities		0
Subtotal		44914722
Profit (10% of subtotal)		4491472.
Total DT&E Cost		49406194

10. Total Production Cost:

Engine & Avionics	3.1027e9
Manufacturing Labor	1.1534e8
Material & Equipment	39988479
Sustaining Engineering	8317228.
Tooling	14324002
Quality Control	14993998
Manufacturing Facilities	0
Subtotal	3.2957e9
Profit (10% of subtotal)	3.2957e8
Total Production Cost	3.6253e9

C4.6. COST ANALYSIS FOR NASA COMMUTER FAMILY: Vertical Tail. Commonality Implemented/All Sizes.

Development and Production Costs

Input:	Time =	1987
	AMPR Weight, A (lbs) =	340
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	7
	Production Quantity, Q P =	3500
	Production Rate (planes per month) =	28

9. Total DT&E Cost:

Airframe Engineering		3614053.
Development Support		695098.3
Flight Test Aircraft		43835733
Engines & Avionics	26572308	
Man. Labor	7891204.	
Material & Equipment	854640.4	
Tooling	7491724.	
Quality Control	1025857.	
Flight Test Operations		149986.4
Test Facilities		0
Subtotal		48294870
Profit (10% of subtotal)		4829487.
Total DT&E Cost		53124357

10. Total Production Cost:

Engine & Avionics	1.329e10
Manufacturing Labor	1.9716e8
Material & Equipment	1.1665e8
Sustaining Engineering	7659603.
Tooling	15162692
Quality Control	25630550
Manufacturing Facilities	0
Subtotal	1.365e10
Profit (10% of subtotal)	1.3648e9
Total Production Cost	1.501e10

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C5.1 COST ANALYSIS FOR NASA COMMUTER FAMILY:Fuse. Sections
No Commonality Implemented/25 Pax.
Development and Production Costs

Input:	Time =	1987
	AMPR Weight, A (lbs) =	1982
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4

9. Total DT&E Cost:

Airframe Engineering		12481416
Development Support		2416110.
Flight Test Aircraft		55733789
Engines & Avionics	11388132	
Man. Labor	18658888	
Material & Equipment	1471842.	
Tooling	21789271	
Quality Control	2425655.	
Flight Test Operations		391560.0
Test Facilities		0
Subtotal		71022875
Profit (10% of subtotal)		7102288.
Total DT&E Cost		78125163

10. Total Production Cost:

Engine & Avionics	1.8980e9
Manufacturing Labor	2.5455e8
Material & Equipment	83568124
Sustaining Engineering	19385323
Tooling	32435063
Quality Control	33091583
Manufacturing Facilities	0
Subtotal	2.3211e9
Profit (10% of subtotal)	2.3211e8
Total Production Cost	2.5532e9

C5.2 COST ANALYSIS FOR NASA COMMUTER FAMILY:Fuse. Sections
No Commonality Implemented/36 Pax.

Development and Production Costs

Input:	Time =	1987
	AMPR Weight, A (lbs) =	3483
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4

9. Total DT&E Cost:

Airframe Engineering		19495756
Development Support		3952488.
Flight Test Aircraft		79079181
Engines & Avionics	11388132	
Man. Labor	28318785	
Material & Equipment	2170515.	
Tooling	33520306	
Quality Control	3681442.	
Flight Test Operations		753050.5
Test Facilities		0
Subtotal		1.0328e8
Profit (10% of subtotal)		10328048
Total DT&E Cost		1.1361e8

10. Total Production Cost:

Engine & Avionics	1.8980e9
Manufacturing Labor	3.8633e8
Material & Equipment	1.2324e8
Sustaining Engineering	30279538
Tooling	49897640
Quality Control	50223435
Manufacturing Facilities	0
Subtotal	2.5380e9
Profit (10% of subtotal)	2.5380e8
Total Production Cost	2.7918e9

C5.3 COST ANALYSIS FOR NASA COMMUTER FAMILY:Fuse. Sections
No Commonality Implemented/50 Pax.

Development and Production Costs

Input:	Time =	1987
	AMPR Weight, A (lbs) =	5278
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4

9. Total DT&E Cost:

Airframe Engineering		27084958
Development Support		5681473.
Flight Test Aircraft		1.0385e8
Engines & Avionics	11388132	
Man. Labor	38517350	
Material & Equipment	2890269.	
Tooling	46049205	
Quality Control	5007255.	
Flight Test Operations		1219614.
Test Facilities		0
Subtotal		1.3784e8
Profit (10% of subtotal)		13783826
Total DT&E Cost		1.5162e8

10. Total Production Cost:

Engine & Avionics	1.8980e9
Manufacturing Labor	5.2547e8
Material & Equipment	1.6410e8
Sustaining Engineering	42066592
Tooling	68547901
Quality Control	68310614
Manufacturing Facilities	0
Subtotal	2.7665e9
Profit (10% of subtotal)	2.7665e8
Total Production Cost	3.0432e9

C5.4 COST ANALYSIS FOR NASA COMMUTER FAMILY:Fuse. Sections
No Commonality Implemented/75 Pax.

Development and Production Costs

Input:	Time =	1987
	AMPR Weight, A (lbs) =	6966
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4

9. Total DT&E Cost:

Airframe Engineering		33732988
Development Support		7238853.
Flight Test Aircraft		1.3249e8
Engines & Avionics	18616398	
Man. Labor	47297351	
Material & Equipment	3499230.	
Tooling	56923932	
Quality Control	6148656.	
Flight Test Operations		1682747.
Test Facilities		0
Subtotal		1.7514e8
Profit (10% of subtotal)		17514015
Total DT&E Cost		1.9265e8

10. Total Production Cost:

Engine & Avionics	3.1027e9
Manufacturing Labor	6.4525e8
Material & Equipment	1.9868e8
Sustaining Engineering	52391878
Tooling	84735798
Quality Control	83881968
Manufacturing Facilities	0
Subtotal	4.1677e9
Profit (10% of subtotal)	4.1677e8
Total Production Cost	4.5844e9

C5.5 COST ANALYSIS FOR NASA COMMUTER FAMILY:Fuse. Sections
No Commonality Implemented/100 Pax.
Development and Production Costs

Input:	Time =	1987
	AMPR Weight, A (lbs) =	10556
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4

9. Total DT&E Cost:

Airframe Engineering		46864382
Development Support		10405433
Flight Test Aircraft		1.7417e8
Engines & Avionics	18616398	
Man. Labor	64330747	
Material & Equipment	4659592.	
Tooling	78200413	
Quality Control	8362997.	
Flight Test Operations		2725319.
Test Facilities		0
Subtotal		2.3417e8
Profit (10% of subtotal)		23416528
Total DT&E Cost		2.5758e8

10. Total Production Cost:

Engine & Avionics	3.1027e9
Manufacturing Labor	8.7762e8
Material & Equipment	2.6456e8
Sustaining Engineering	72786704
Tooling	1.1641e8
Quality Control	1.1409e8
Manufacturing Facilities	0
Subtotal	4.5482e9
Profit (10% of subtotal)	4.5482e8
Total Production Cost	5.0030e9

C5.6 COST ANALYSIS FOR NASA COMMUTER FAMILY:Fuse. Sections Commonality Implemented/All Airplanes.

Development and Production Costs

Input:	Time =	1987
	AMPR Weight, A (lbs) =	2158
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	7
	Production Quantity, Q P =	3500
	Production Rate (planes per month) =	28

9. Total DT&E Cost:

Airframe Engineering		15589397
Development Support		3488928.
Flight Test Aircraft		95373200
Engines & Avionics	26572308	
Man. Labor	30977542	
Material & Equipment	3053205.	
Tooling	30743065	
Quality Control	4027080.	
Flight Test Operations		1279487.
Test Facilities		0
Subtotal		1.1573e8
Profit (10% of subtotal)		11573101
Total DT&E Cost		1.2730e8

10. Total Production Cost:

Engine & Avionics	1.329e10
Manufacturing Labor	7.7396e8
Material & Equipment	4.1673e8
Sustaining Engineering	33040083
Tooling	62221679
Quality Control	1.0061e8
Manufacturing Facilities	0
Subtotal	1.467e10
Profit (10% of subtotal)	1.4673e9
Total Production Cost	1.614e10

C5.7 COST ANALYSIS FOR NASA COMMUTER FAMILY:Fuse. Sections Commonality Implemented/Excess on 36, 75 Pax.

Development and Production Costs

Input:	Time =	1987
	AMPR Weight, A (lbs) =	1417
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	1500
	Production Rate (planes per month) =	12

9. Total DT&E Cost:

Airframe Engineering		9571686.
Development Support		1802566.
Flight Test Aircraft		47134221
Engines & Avionics	11388132	
Man. Labor	14556023	
Material & Equipment	1168021.	
Tooling	18129761	
Quality Control	1892283.	
Flight Test Operations		265306.0
Test Facilities		0
Subtotal		58773778
Profit (10% of subtotal)		5877378.
Total DT&E Cost		64651156

10. Total Production Cost:

Engine & Avionics	5.6941e9
Manufacturing Labor	3.6368e8
Material & Equipment	1.5942e8
Sustaining Engineering	20286178
Tooling	36693290
Quality Control	47277814
Manufacturing Facilities	0
Subtotal	6.321e9
Profit (10% of subtotal)	6.321e8
Total Production Cost	6.9536e9

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C5.8 COST ANALYSIS FOR NASA COMMUTER FAMILY:Fuse. Sections
Commonality Implemented/Excess on 50, 100 Pax.
Development and Production Costs

Input:	Time =	1987
	AMPR Weight, A (lbs) =	3120
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	1500
	Production Rate (planes per month) =	12

9. Total DT&E Cost:

Airframe Engineering		17870272
Development Support		3590394.
Flight Test Aircraft		76031853
Engines & Avionics	11388132	
Man. Labor	26103783	
Material & Equipment	2012006.	
Tooling	33134440	
Quality Control	3393492.	
Flight Test Operations		662792.2
Test Facilities		0
Subtotal		98155312
Profit (10% of subtotal)		9815531.
Total DT&E Cost		1.0797e8

10. Total Production Cost:

Engine & Avionics	5.6941e9
Manufacturing Labor	6.5219e8
Material & Equipment	2.7462e8
Sustaining Engineering	37874157
Tooling	67061644
Quality Control	84784818
Manufacturing Facilities	0
Subtotal	6.8106e9
Profit (10% of subtotal)	6.8106e8
Total Production Cost	7.4917e9

C6.1. COST ANALYSIS FOR NASA COMMUTER FAMILY: Wing.
No Commonality Implemented/25 Pax.

Development and Production Costs

Input:	Time =	1987
	Empty Weight (lbs) =	16050
	AMPR Weight, A (lbs) =	1587
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4

9. Total DT&E Cost:

Airframe Engineering		10469145
Development Support		1989981.
Flight Test Aircraft		48924245
Engines & Avionics	11388132	
Man. Labor	15829091	
Material & Equipment	1262858.	
Tooling	18386383	
Quality Control	2057782.	
Flight Test Operations		302571.0
Test Facilities		0
Subtotal		61685942
Profit (10% of subtotal)		6168594.
Total DT&E Cost		67854536

10. Total Production Cost:

Engine & Avionics	1.8980e9
Manufacturing Labor	2.1595e8
Material & Equipment	71702408
Sustaining Engineering	16259994
Tooling	27369592
Quality Control	28072932
Manufacturing Facilities	0
Subtotal	2.2574e9
Profit (10% of subtotal)	2.2574e8
Total Production Cost	2.4831e9

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C6.2. COST ANALYSIS FOR NASA COMMUTER FAMILY: Wing.
No Commonality Implemented/36 Pax.
Development and Production Costs

Input:	Time =	1987
	Empty Weight (lbs) =	20177
	AMPR Weight, A (lbs) =	1975
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4

9. Total DT&E Cost:

Airframe Engineering		12446535
Development Support		2408659.
Flight Test Aircraft		55616257
Engines & Avionics	11388132.	
Man. Labor	18610100	
Material & Equipment	1468259.	
Tooling	21730453	
Quality Control	2419313.	
Flight Test Operations		389956.2
Test Facilities		0
Subtotal		70861407
Profit (10% of subtotal)		7086141.
Total DT&E Cost		77947547

10. Total Production Cost:

Engine & Avionics	1.8980e9
Manufacturing Labor	2.5389e8
Material & Equipment	83364658
Sustaining Engineering	19331147
Tooling	32347507
Quality Control	33005058
Manufacturing Facilities	0
Subtotal	2.3200e9
Profit (10% of subtotal)	2.3200e8
Total Production Cost	2.5520e9

C6.3. COST ANALYSIS FOR NASA COMMUTER FAMILY: Wing. No Commonality Implemented/50 Pax.

Development and Production Costs

Input:	Time =	1987
	Empty Weight (lbs) =	25153
	AMPR Weight, A (lbs) =	2899
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4

9. Total DT&E Cost:

Airframe Engineering		16861384
Development Support		3367347.
Flight Test Aircraft		70372150
Engines & Avionics	11388132	
Man. Labor	24722520	
Material & Equipment	1912696.	
Tooling	29134875	
Quality Control	3213928.	
Flight Test Operations		608647.7
Test Facilities		0
Subtotal		91209529
Profit (10% of subtotal)		9120953.
Total DT&E Cost		1.0033e8

10. Total Production Cost:

Engine & Avionics	1.8980e9
Manufacturing Labor	3.3727e8
Material & Equipment	1.0860e8
Sustaining Engineering	26188003
Tooling	43369577
Quality Control	43845449
Manufacturing Facilities	0
Subtotal	2.4573e9
Profit (10% of subtotal)	2.4573e8
Total Production Cost	2.7030e9

C6.4. COST ANALYSIS FOR NASA COMMUTER FAMILY: Wing. No Commonality Implemented/75 Pax.
Development and Production Costs

Input: Time =	1987
Empty Weight (lbs) =	40024
AMPR Weight, A (lbs) =	3068
Maximum Speed, S (kts) =	412
Flight Test Quantity, Q D =	3
Production Quantity, Q P =	500
Production Rate (planes per month) =	4

9. Total DT&E Cost:

Airframe Engineering		17634269
Development Support		3538098.
Flight Test Aircraft		80161690
Engines & Avionics	18616398	
Man. Labor	25781134	
Material & Equipment	1988842.	
Tooling	30423769	
Quality Control	3351547.	
Flight Test Operations		649995.4
Test Facilities		0
Subtotal		1.0198e8
Profit (10% of subtotal)		10198405
Total DT&E Cost		1.1218e8

10. Total Production Cost:

Engine & Avionics	3.1027e9
Manufacturing Labor	3.5171e8
Material & Equipment	1.1292e8
Sustaining Engineering	27388398
Tooling	45288198
Quality Control	45722904
Manufacturing Facilities	0
Subtotal	3.6858e9
Profit (10% of subtotal)	3.6858e8
Total Production Cost	4.0543e9

C6.5. COST ANALYSIS FOR NASA COMMUTER FAMILY: Wing. No Commonality Implemented/100 Pax.

Development and Production Costs

Input:	Time =	1987
	Empty Weight (lbs) =	49071
	AMPR Weight, A (lbs) =	4349
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	3
	Production Quantity, Q P =	500
	Production Rate (planes per month) =	4

9. Total DT&E Cost:

Airframe Engineering		23239186
Development Support		4797988.
Flight Test Aircraft		98578658
Engines & Avionics	18616398	
Man. Labor	33376225	
Material & Equipment	2529340.	
Tooling	39717786	
Quality Control	4338909.	
Flight Test Operations		974293.4
Test Facilities		0
Subtotal		1.2759e8
Profit (10% of subtotal)		12759012
Total DT&E Cost		1.4035e8

10. Total Production Cost:

Engine & Avionics	3.1027e9
Manufacturing Labor	4.5533e8
Material & Equipment	1.4361e8
Sustaining Engineering	36093589
Tooling	59123081
Quality Control	59192816
Manufacturing Facilities	0
Subtotal	3.8561e9
Profit (10% of subtotal)	3.8561e8
Total Production Cost	4.2417e9

C6.6. COST ANALYSIS FOR NASA COMMUTER FAMILY: Wing. Commonality Implemented/All Sizes.
Development and Production Costs

Input:	Time =	1987
	AMPR Weight, A (lbs) =	2899
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	5
	Production Quantity, Q P =	2500
	Production Rate (planes per month) =	20

9. Total DT&E Cost:

Airframe Engineering		18513628
Development Support		4018348.
Flight Test Aircraft		93841525
Engines & Avionics	18980220	
Man. Labor	32310336	
Material & Equipment	2866488.	
Tooling	35484138	
Quality Control	4200344.	
Flight Test Operations		1170993.
Test Facilities		0
Subtotal		1.1754e8
Profit (10% of subtotal)		11754449
Total DT&E Cost		1.2930e8

10. Total Production Cost:

Engine & Avionics	9.4901e9
Manufacturing Labor	8.0726e8
Material & Equipment	3.9125e8
Sustaining Engineering	39237683
Tooling	71817258
Quality Control	1.0494e8
Manufacturing Facilities	0
Subtotal	1.090e10
Profit (10% of subtotal)	1.0905e9
Total Production Cost	1.200e10

C6.7. COST ANALYSIS FOR NASA COMMUTER FAMILY: Wing. Commonality Implemented/Mid-sections for twins.
Development and Production Costs

Input:	Time =	1987
	AMPR Weight, A (lbs) =	1450
	Maximum Speed, S (kts) =	412
	Flight Test Quantity, Q D =	2
	Production Quantity, Q P =	1000
	Production Rate (planes per month) =	8

9. Total DT&E Cost:

Airframe Engineering		9050494.
Development Support		1598424.
Flight Test Aircraft		38694668
Engines & Avionics	7592088	
Man. Labor	11972078	
Material & Equipment	860746.2	
Tooling	16713385	
Quality Control	1556370.	
Flight Test Operations		162095.9
Test Facilities		0
Subtotal		49505681
Profit (10% of subtotal)		4950568.
Total DT&E Cost		54456249

10. Total Production Cost:

Engine & Avionics	3.7960e9
Manufacturing Labor	2.9912e8
Material & Equipment	1.1748e8
Sustaining Engineering	19181567
Tooling	33826649
Quality Control	38885187
Manufacturing Facilities	0
Subtotal	4.3045e9
Profit (10% of subtotal)	4.3045e8
Total Production Cost	4.7350e9

APPENDIX D: SENSITIVITY ANALYSIS OF COST PARAMETERS.

The purpose of this appendix is to show the effect of changes in the costing parameters on the baseline acquisition costs. These are calculated for both the RDT&E costs and the subsequent production costs. The calculations were done with the help of a SuperCalc3 spreadsheet using the partial derivatives of the Ref. 5 equations.

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D1. SENSITIVITY ANALYSIS OF DEVELOPMENT COST PARAMETERS: *
NASA Family of Commuter Airplanes

						D p 1 =		10
						SHP 1 =		5500
Development and Production Variables:						SHP 2 =		11000
						D p 2 =		14
Q D =	3		S (kts)=	412		E.Rate=		65
Q P =	500		R (mnth)=	4		T.Rate=		55
Q D+Q P=	503					M.Rate=		50

	Airplane	W E(lbs)	A (lbs)	dE/dA	dE/dS	dE/dQ	dD/dA
1.	25 Pax	16050	10593	3506.510	173976.0	2848137.	287.9951
2.	36 Pax	20177	13316.82	3342.753	208497.2	3413279.	279.7459
3.	50 Pax	25153	16600.98	3192.244	248213.4	4063467.	272.0230
4.	75 Twin	40024	26415.84	2896.906	358421.6	5867670.	256.4400
5.	100 Twin	49071	32386.86	2776.112	421115.5	6894022.	249.8882
6.	75 Sing	48175	31795.5	2786.824	415021.6	6794260.	250.4737
7.	100 sing	66041	43587.06	2609.025	532636.9	8719725.	240.6380

	dD/dS	dD/dQD	dF/dA	dF/dS	dF/dQ	dT/dA	dT/dS
1.	15925.16	403978.3	96.90529	3025.451	391054.4	5655.148	171092.3
2.	19446.60	493307.9	100.5191	3945.234	509940.8	5357.843	203778.3
3.	23573.22	597989.0	104.1276	5094.754	658522.0	5086.241	241156.0
4.	35361.43	897024.0	112.1612	8732.344	1128698.	4558.149	343890.6
5.	42246.83	1071688.	115.8787	11061.04	1429694.	4344.116	401825.7
6.	41572.62	1054585.	115.5375	10827.10	1399456.	4363.050	396208.0
7.	54752.16	1388915.	121.5183	15610.72	2017762.	4050.047	504179.4

	dT/dQ	dT/dR	dL/dA	dL/dS	dL/dQ	dQC/dA	dQC/dS
1.	4652568.	1293574.	4505.600	85003.56	11265854	585.7280	11050.46
2.	5541409.	1540703.	4245.349	100688.4	13344628	551.8954	13089.49
3.	6557834.	1823304.	4008.877	118528.3	15709017	521.1540	15408.68
4.	9351529.	2600047.	3552.817	167148.6	22152857	461.8661	21729.32
5.	10926977	3038076.	3369.470	194355.1	25758645	438.0311	25266.17
6.	10774214	2995602.	3385.653	191722.7	25409765	440.1349	24923.96
7.	13710314	3811940.	3119.066	242129.5	32090366	405.4786	31476.83

	dQC/dQ	dM/dA	dM/dS	dM/dQ	d$/dshp	d$/dDp	d$/dEp
1.	1464561.	101.2683	2358.045	411029.3	172.1079	59801.46	7.413431
2.	1734802.	94.31181	2760.743	481223.4	172.1079	59801.46	7.413431
3.	2042172.	88.06291	3213.559	560153.3	172.1079	59801.46	7.413431
4.	2879871.	76.21752	4425.666	771435.0	149.8286	83925.26	7.282796
5.	3348624.	71.53687	5092.819	887725.9	149.8286	83925.26	7.282796
6.	3303269.	71.94803	5028.564	876525.8	149.8286	83925.26	7.282796
7.	4171748.	65.22505	6249.301	1089312.	149.8286	83925.26	7.282796

*All values are for 3 flight test airplanes.

D2. SENSITIVITY ANALYSIS OF PRODUCTION COST PARAMETERS: *
NASA Family of Commuter Airplanes

				D p 1 =	10
				SHP 1 =	5500
Development and Production Variables:				SHP 2 =	11000
				D p 2 =	14
Q P =	500	S (kts)=	412	E.Rate=	65
Q D+Q P=	503	R (mnth)=	4	T.Rate=	55
				M.Rate=	50

	Airplane	W E(lbs)	A (lbs)	dE/dA	dE/dS	dE/dQ	dD/dA
1.	25 Pax	16050	10593	8942.797	443698.3	43582.34	1691.005
2.	36 Pax	20177	13316.82	8525.162	531739.1	52230.16	1642.568
3.	50 Pax	25153	16600.98	8141.312	633028.9	62179.37	1597.222
4.	75 Twin	40024	26415.84	7388.099	914097.5	89787.37	1505.724
5.	100 Twin	49071	32386.86	7080.033	1073988.	105492.7	1467.254
6.	75 Sing	48175	31795.5	7107.354	1058447.	103966.1	1470.692
7.	100 sing	66041	43587.06	6653.905	1358406.	133429.7	1412.940

	dD/dS	dD/dQD	dF/dA	dF/dS	dF/dQ	dT/dA	dT/dS
1.	93506.84	14232.10	68004.20	2123139.	1646557.	14058.31	425323.6
2.	114183.5	17379.17	70540.22	2768605.	2147135.	13319.23	506578.8
3.	138413.5	21067.07	73072.52	3575292.	2772744.	12644.04	599497.2
4.	207629.7	31602.03	78710.20	6128005.	4752448.	11331.24	854888.4
5.	248058.3	37755.42	81318.94	7762189.	6019806.	10799.17	998911.0
6.	244099.6	37152.89	81079.53	7598022.	5892489.	10846.24	984945.9
7.	321485.2	48931.27	85276.61	10954969	8495901.	10068.14	1253355.

	dT/dQ	dT/dR	dL/dA	dL/dS	dL/dQ	dQC/dA	dQC/dS
1.	69395.78	3215736.	65765.99	1240754.	986652.2	8549.578	161298.1
2.	82653.37	3830080.	61967.24	1469698.	1168709.	8055.741	191060.8
3.	97813.93	4532607.	58515.58	1730098.	1375780.	7607.025	224912.8
4.	139483.5	6463538.	51858.69	2439785.	1940125.	6741.629	317172.0
5.	162982.3	7552447.	49182.47	2836905.	2255916.	6393.722	368797.6
6.	160703.7	7446861.	49418.69	2798481.	2225362.	6424.429	363802.6
7.	204497.4	9476219.	45527.45	3534243.	2610442.	5918.568	459451.6

	dQC/dQ	dM/dA	dM/dS	dM/dQ	d$/dshp	d$/dDp	d$/dEp
1.	128264.8	5823.418	135599.0	141817.0	172.1079	59801.46	7.413431
2.	151932.2	5423.383	158756.0	166036.0	172.1079	59801.46	7.413431
3.	178851.4	5064.041	184795.1	193269.1	172.1079	59801.46	7.413431
4.	252216.3	4382.874	254497.1	266167.4	149.8286	83925.26	7.282796
5.	293269.1	4113.714	292861.6	306291.1	149.8286	83925.26	7.282796
6.	289297.0	4137.358	289166.7	302426.7	149.8286	83925.26	7.282796
7.	365357.5	3750.754	359364.9	375844.0	149.8286	83925.26	7.282796

*All values are for 500 production airplanes.

APPENDIX E: DOC COSTING CALCULATIONS.

The purpose of this appendix is to show the various costing parameters and calculated output for the two different DOC methods. Refs. 11 and 12 were used to obtain the methods for this analysis. Ref. 13 and 14 were used to verify that the costing parameters were in the range of legitimate values.

Contents

E1.1. DIRECT OPERATING COSTS FOR COMMUTER FAMILY
Method: Modified ATA Formulas, Beech Report, 1986.

Costs, $/flight.	25 Pax	36 Pax	50 Pax	75 Pax	100 Pax
Crew, Cc	124.80	187.20	187.20	249.60	249.60
Fuel, Cf	149.25	149.25	149.25	298.51	298.51
Hull Ins., Ci	19.15	20.66	22.39	33.98	36.61
Depreciation, Cd	99.95	106.94	114.88	177.58	189.66
Airframe Maint. Labor, Cal	3287.36	3739.87	4275.35	5817.18	6717.61
Airframe Maint. Material, Cam	620.88	840.85	1133.60	2716.26	3583.71
Propulsion Sys. Maint. Lab., Cpl	20.43	20.43	20.43	20.72	20.72
Propulsion Sys. Maint. Mat., Cpm	103.23	103.23	103.23	145.91	145.91
Totals ($/flight)	4425.06	5168.45	6006.34	9459.74	11242.34
Totals ($/bhr)	2876.29	3359.49	3904.12	6148.83	7307.52
Totals ($/Pax)	177.00	143.57	120.13	126.13	112.42

Calculated DOC Breakdowns with Input Parameters ($/Flight).

Variable	25 Pax	36 Pax	50 Pax	75 Pax	100 Pax
CREW COST, C-c	124.80	187.20	187.20	249.60	249.60
No. of crew, N-c	2.00	3.00	3.00	4.00	4.00
Crew Rate, K-c	96.00	96.00	96.00	96.00	96.00
Block time, t-b	.65	.65	.65	.65	.65
FUEL COST, C-f	149.25	149.25	149.25	298.51	298.51
Jet Fuel Price,P-f	1.00	1.00	1.00	1.00	1.00
Block fuel, F-b	1000.00	1000.00	1000.00	2000.00	2000.00
HULL INS COST, C-i	19.15	20.66	22.39	33.98	36.61
Block time, t-b	.65	.65	.65	.65	.65
Acquis. cost, C-t	7363689	7948048	8611920	13069259	14079259
Ann. ins. rate, IR	.01	.01	.01	.01	.01
Annual utiliz., U	2500.00	2500.00	2500.00	2500.00	2500.00

DEPREC. COST, C-d	99.95	106.94	114.88	177.58	189.66
Deprec period, D-a	10.00	10.00	10.00	10.00	10.00
Acquis. cost, C-t	7363689	7948048	8611920	13069259	14079259
Prop sys cost, C-p	3046044	3046044	3046044	5455466	5455466
Annual utiliz., U	2500.00	2500.00	2500.00	2500.00	2500.00
Block time, t-b	.65	.65	.65	.65	.65
AIRFRAME MAINT. LABOR COST, C-al	3287.36	3739.87	4275.35	5817.18	6717.61
Lab hr/flt hr, K-1	1.01	1.14	1.31	1.78	2.06
Lab hr/flt cy, K-2	1.71	1.94	2.22	3.02	3.49
Flight time, t-f	.49	.49	.49	.49	.49
Block time, t-b	.65	.65	.65	.65	.65
Ground time, t-g	.16	.16	.16	.16	.16
Labor rate, LR	21.67	21.67	21.67	21.67	21.67
O/H burden fac., B	1.80	1.80	1.80	1.80	1.80
Airframe wght, W-a	10593	13317	16601	26416	32387
AIRFRAME MAINT. MATER COST, C-am	620.88	840.85	1133.60	2716.26	3583.71
Mat. hrly fac, K-3	23.30	25.10	27.14	40.87	43.98
Mat. cyc fac, K-4	47.20	50.84	54.99	82.80	89.10
Airframe cost, C-a	7363689	7948048	8611920	13069259	14079259
Opt Av&Eq Pr.,C-ae	200000	200000	200000	200000	200000
Airframe wght, W-a	10593	13317	16601	26416	32387
Flight time, t-f	.49	.49	.49	.49	.49
Block time, t-b	.65	.65	.65	.65	.65
Ground time, t-g	.16	.16	.16	.16	.16
PROPUL SYS MAINT LABOR COST, C-pl	20.43	20.43	20.43	20.72	20.72
No of engines, N-e	2.00	2.00	2.00	2.00	2.00
Lab.hrs/hr/eng,K-5	.47	.47	.47	.48	.48
Lab.hrs/cy/eng,K-6	.03	.03	.03	.03	.03
Labor rate, LR	21.67	21.67	21.67	21.67	21.67
O/H burden fac., B	1.80	1.80	1.80	1.80	1.80
Prop diam., Dia	10.00	10.00	10.00	14.00	14.00
No of blades, N-b	12.00	12.00	12.00	12.00	12.00
PROPUL SYS MAINT MATER COST, C-pm	103.23	103.23	103.23	145.91	145.91
No of engines, N-e	2.00	2.00	2.00	2.00	2.00
Mat cost/fl hr,K-7	75.07	75.07	75.07	106.08	106.08
Mat cost/fl cy,K-8	14.83	14.83	14.83	20.98	20.98
SHP at SLS, P-t	5500.00	5500.00	5500.00	11000.00	11000.00
Prop diam., Dia	10.00	10.00	10.00	14.00	14.00
No of blades, N-b	12.00	12.00	12.00	12.00	12.00

E1.2. DIRECT OPERATING COSTS FOR COMMUTER FAMILY
Method: Modified NLF Formulas, Williams Report, 1985.

Costs, $/block hr	25 Pax	36 Pax	50 Pax	75 Pax	100 Pax
Crew	2955.32	3166.95	3343.73	3886.21	4094.08
Fuel	229.62	229.62	229.62	459.24	459.24
Insurance	38.24	42.31	47.12	71.40	79.14
Depreciation	288.17	309.03	332.73	511.85	547.91
Oil	1.33	1.33	1.33	2.67	2.67
Maintenance Labor Airframe	20.33	25.90	32.62	52.70	64.92
Parts-Airframe	48.04	53.36	59.40	84.95	94.14
Maintenance Labor Engines	15.92	15.92	15.92	15.92	15.92
Parts-Engines	118.33	118.33	118.33	211.92	211.92
Engine Reserves	2.32	2.32	2.32	2.32	2.32
Totals ($/bhr)	3717.61	3965.07	4183.12	5299.20	5572.27
Totals ($/flight)	5719.40	6100.11	6435.57	8152.61	8572.73
Totals ($/Pax)	228.78	169.45	128.71	108.70	85.73

Calculated DOC Breakdowns with Input Parameters ($/Block hr).

Variable	25 Pax	36 Pax	50 Pax	75 Pax	100 Pax
CREW ($/Bhr)	2955.32	3166.95	3343.73	3886.21	4094.08
CREW ($/St. Mile)	8.26	8.85	9.34	10.86	11.44
T.O.G.W. (lbs)	28506	35954	43141	71419	85044
Cruise Speed (kts)	412.00	412.00	412.00	412.00	412.00
Block speed	358.00	358.00	358.00	358.00	358.00
FUEL COST	229.62	229.62	229.62	459.24	459.24
Jet Fuel Price/gal	1.00	1.00	1.00	1.00	1.00
Block fuel (lbs)	1000.00	1000.00	1000.00	2000.00	2000.00
Block time (hrs)	.65	.65	.65	.65	.65
INSURANCE COST	38.24	42.31	47.12	71.40	79.14
# of Pass. Seats	25.00	36.00	50.00	75.00	100.00
Initial cost ($)	7363689	7948048	8611920	13069259	14079259
Annual util.(bhrs)	2500.00	2500.00	2500.00	2500.00	2500.00

DEPRECIATION	288.17	309.03	332.73	511.85	547.91
Initial cost ($)	7363689	7948048	8611920	13069259	14079259
Cost of engines($)	3046044	3046044	3046044	5455466	5455466
Annual util.(bhrs)	2500.00	2500.00	2500.00	2500.00	2500.00
MAINTENANCE					
LABOR AIRFRAME	20.33	25.90	32.62	52.70	64.92
Flight time (bhrs)	.49	.49	.49	.49	.49
Block time (bhrs)	.65	.65	.65	.65	.65
Ground time (bhrs)	.16	.16	.16	.16	.16
Engine Wght (lbs)	1000.00	1000.00	1000.00	1000.00	1000.00
O.W.E. (lbs)	16050	20177	25153	40024	49071
Labor rate ($/hr)	21.67	21.67	21.67	21.67	21.67
PARTS-AIRFRAME	48.04	53.36	59.40	84.95	94.14
Initial cost ($)	7363689	7948048	8611920	13069259	14079259
Cost of engines($)	3046044	3046044	3046044	5455466	5455466
Flight time (bhrs)	.49	.49	.49	.49	.49
Block time (bhrs)	.65	.65	.65	.65	.65
Ground time (bhrs)	.16	.16	.16	.16	.16
MAINTENANCE					
LABOR ENGINES	15.92	15.92	15.92	15.92	15.92
No of engines	2.00	2.00	2.00	2.00	2.00
Labor rate ($/hr)	21.67	21.67	21.67	21.67	21.67
Flight time (bhrs)	.49	.49	.49	.49	.49
Block time (bhrs)	.65	.65	.65	.65	.65
Ground time (bhrs)	.16	.16	.16	.16	.16
PARTS-ENGINES	118.33	118.33	118.33	211.92	211.92
No of engines	2.00	2.00	2.00	2.00	2.00
Cost of engines($)	3046044	3046044	3046044	5455466	5455466
Flight time (bhrs)	.49	.49	.49	.49	.49
Block time (bhrs)	.65	.65	.65	.65	.65
OIL	1.33	1.33	1.33	2.67	2.67
No of engines	2.00	2.00	2.00	2.00	2.00
Oil cost ($/gal)	15.00	15.00	15.00	15.00	15.00
Flight time (bhrs)	.49	.49	.49	.49	.49
Block time (bhrs)	.65	.65	.65	.65	.65
SHP per engine	5500.00	5500.00	5500.00	11000.00	11000.00
ENGINE RESERVES	2.32	2.32	2.32	2.32	2.32
Overhaul cost ($)	1400.00	1400.00	1400.00	1400.00	1400.00
OH time lapse(bhr)	1000.00	1000.00	1000.00	1000.00	1000.00
No of engines	2.00	2.00	2.00	2.00	2.00
Flight time (bhrs)	.49	.49	.49	.49	.49
Block time (bhrs)	.65	.65	.65	.65	.65

E2.1. COMMON DIRECT OPERATING COSTS FOR COMMUTER FAMILY
Method: Modified ATA Formulas, Beech Report, 1986.

Costs, $/flight.	25 Pax	36 Pax	50 Pax	75 Pax	100 Pax
Crew, Cc	124.80	187.20	187.20	249.60	249.60
Fuel, Cf	149.25	149.25	149.25	298.51	298.51
Hull Ins., Ci	15.77	17.29	19.02	30.60	33.23
Depreciation, Cd	84.42	91.41	99.35	162.06	174.13
Airframe Maint. Labor, Cal	3612.58	3956.90	4275.34	6183.27	6752.40
Airframe Maint. Material, Cam	609.13	777.08	966.57	2673.73	3281.40
Propulsion Sys. Maint. Lab., Cpl	17.03	17.03	17.03	17.27	17.27
Propulsion Sys. Maint. Mat., Cpm	103.23	103.23	103.23	145.91	145.91
Totals ($/flight)	4716.22	5299.40	5816.99	9760.96	10952.45
Totals ($/bhr)	7255.72	8152.92	8949.22	15016.85	16849.93
Totals ($/Pax)	188.65	147.21	116.34	130.15	109.52

Calculated DOC Breakdowns with Input Parameters ($/Flight).

Variable	25 Pax	36 Pax	50 Pax	75 Pax	100 Pax
CREW COST, C-c	124.80	187.20	187.20	249.60	249.60
No. of crew, N-c	2.00	3.00	3.00	4.00	4.00
Crew Rate, K-c	96.00	96.00	96.00	96.00	96.00
Block time, t-b	.65	.65	.65	.65	.65
FUEL COST, C-f	149.25	149.25	149.25	298.51	298.51
Jet Fuel Price,P-f	1.00	1.00	1.00	1.00	1.00
Block fuel, F-b	1000.00	1000.00	1000.00	2000.00	2000.00
HULL INS COST, C-i	15.77	17.29	19.02	30.60	33.23
Block time, t-b	.65	.65	.65	.65	.65
Acquis. cost, C-t	6065436	6649615	7313487	11770826	12780826
Ann. ins. rate, IR	.01	.01	.01	.01	.01
Annual utiliz., U	2500.00	2500.00	2500.00	2500.00	2500.00

DEPREC. COST, C-d	84.42	91.41	99.35	162.06	174.13
Deprec period, D-a	10.00	10.00	10.00	10.00	10.00
Acquis. cost, C-t	6065436	6649615	7313487	11770826	12780826
Prop sys cost, C-p	3046044	3046044	3046044	5455466	5455466
Annual utiliz., U	2500.00	2500.00	2500.00	2500.00	2500.00
Block time, t-b	.65	.65	.65	.65	.65

AIRFRAME MAINT.					
LABOR COST, C-al	3612.58	3956.90	4275.34	6183.27	6752.40
Lab hr/flt hr, K-1	1.11	1.21	1.31	1.89	2.07
Lab hr/flt cy, K-2	1.87	2.05	2.22	3.21	3.50
Flight time, t-f	.49	.49	.49	.49	.49
Block time, t-b	.65	.65	.65	.65	.65
Ground time, t-g	.16	.16	.16	.16	.16
Labor rate, LR	21.67	21.67	21.67	21.67	21.67
O/H burden fac., B	1.50	1.50	1.50	1.50	1.50
Airframe wght, W-a	12545.94	14640.12	16600.98	28822.86	32621.16

AIRFRAME MAINT.					
MATER COST, C-am	609.13	777.08	966.57	2673.73	3281.40
Mat. hrly fac, K-3	19.30	21.10	23.14	36.87	39.98
Mat. cyc fac, K-4	39.10	42.74	46.88	74.70	81.00
Airframe cost, C-a	6065436	6649615	7313487	11770826	12780826
Opt Av&Eq Pr.,C-ae	200000	200000	200000	200000	200000
Airframe wght, W-a	12545.94	14640.12	16600.98	28822.86	32621.16
Flight time, t-f	.49	.49	.49	.49	.49
Block time, t-b	.65	.65	.65	.65	.65
Ground time, t-g	.16	.16	.16	.16	.16

PROPUL SYS MAINT					
LABOR COST, C-pl	17.03	17.03	17.03	17.27	17.27
No of engines, N-e	2.00	2.00	2.00	2.00	2.00
Lab.hrs/hr/eng,K-5	.47	.47	.47	.48	.48
Lab.hrs/cy/eng,K-6	.03	.03	.03	.03	.03
Labor rate, LR	21.67	21.67	21.67	21.67	21.67
O/H burden fac., B	1.50	1.50	1.50	1.50	1.50
Prop diam., Dia	10.00	10.00	10.00	14.00	14.00
No of blades, N-b	12.00	12.00	12.00	12.00	12.00

PROPUL SYS MAINT					
MATER COST, C-pm	103.23	103.23	103.23	145.91	145.91
No of engines, N-e	2.00	2.00	2.00	2.00	2.00
Mat cost/fl hr,K-7	75.07	75.07	75.07	106.08	106.08
Mat cost/fl cy,K-8	14.83	14.83	14.83	20.98	20.98
SHP at SLS, P-t	5500.00	5500.00	5500.00	11000.00	11000.00
Prop diam., Dia	10.00	10.00	10.00	14.00	14.00
No of blades, N-b	12.00	12.00	12.00	12.00	12.00

E2.2. COMMON DIRECT OPERATING COSTS FOR COMMUTER FAMILY
Method: Modified NLF Formulas, Williams Report, 1985.

Costs, $/block hr	25 Pax	36 Pax	50 Pax	75 Pax	100 Pax
Crew	2955.32	3166.95	3343.73	3886.21	4094.08
Fuel	229.62	229.62	229.62	459.24	459.24
Insurance	32.00	36.08	40.88	65.17	72.91
Depreciation	241.82	262.67	286.37	465.50	501.56
Oil	1.33	1.33	1.33	2.67	2.67
Maintenance Labor Airframe	24.32	28.61	32.62	57.63	65.40
Parts-Airframe	36.22	41.53	47.58	73.13	82.32
Maintenance Labor Engines	15.92	15.92	15.92	15.92	15.92
Parts-Engines	118.33	118.33	118.33	211.92	211.92
Engine Reserves	2.32	2.32	2.32	2.32	2.32
Totals ($/bhr)	3657.21	3903.37	4118.71	5239.71	5508.34
Totals ($/flight)	2377.19	2537.19	2677.16	3405.81	3580.42
Totals ($/Pax)	95.09	70.48	53.54	45.41	35.80

Calculated DOC Breakdowns with Input Parameters ($/Block hr).

Variable	25 Pax	36 Pax	50 Pax	75 Pax	100 Pax
CREW ($/Bhr)	2955.32	3166.95	3343.73	3886.21	4094.08
CREW ($/St. Mile)	8.26	8.85	9.34	10.86	11.44
T.O.G.W. (lbs)	28506.00	35954.00	43141.00	71419.00	85044.00
Cruise Speed (kts)	412.00	412.00	412.00	412.00	412.00
Block speed	358.00	358.00	358.00	358.00	358.00
FUEL COST	229.62	229.62	229.62	459.24	459.24
Jet Fuel Price/gal	1.00	1.00	1.00	1.00	1.00
Block fuel (lbs)	1000.00	1000.00	1000.00	2000.00	2000.00
Block time (hrs)	.65	.65	.65	.65	.65
INSURANCE COST	32.00	36.08	40.88	65.17	72.91
# of Pass. Seats	25.00	36.00	50.00	75.00	100.00
Initial cost ($)	6065436	6649615	7313487	11770826	12780826
Annual util.(bhrs)	2500.00	2500.00	2500.00	2500.00	2500.00

DEPRECIATION	241.82	262.67	286.37	465.50	501.56
Initial cost ($)	6065436	6649615	7313487	11770826	12780826
Cost of engines($)	3046044	3046044	3046044	5455466	5455466
Annual util.(bhrs)	2500.00	2500.00	2500.00	2500.00	2500.00
MAINTENANCE					
LABOR AIRFRAME	24.32	28.61	32.62	57.63	65.40
Flight time (bhrs)	.49	.49	.49	.49	.49
Block time (bhrs)	.65	.65	.65	.65	.65
Ground time (bhrs)	.16	.16	.16	.16	.16
Engine Wght (lbs)	1000.00	1000.00	1000.00	1000.00	1000.00
O.W.E. (lbs)	19009.00	22182.00	25153.00	43671.00	49426.00
Labor rate ($/hr)	21.67	21.67	21.67	21.67	21.67
PARTS-AIRFRAME	36.22	41.53	47.58	73.13	82.32
Initial cost ($)	6065436	6649615	7313487	11770826	12780826
Cost of engines($)	3046044	3046044	3046044	5455466	5455466
Flight time (bhrs)	.49	.49	.49	.49	.49
Block time (bhrs)	.65	.65	.65	.65	.65
Ground time (bhrs)	.16	.16	.16	.16	.16
MAINTENANCE					
LABOR ENGINES	15.92	15.92	15.92	15.92	15.92
No of engines	2.00	2.00	2.00	2.00	2.00
Labor rate ($/hr)	21.67	21.67	21.67	21.67	21.67
Flight time (bhrs)	.49	.49	.49	.49	.49
Block time (bhrs)	.65	.65	.65	.65	.65
Ground time (bhrs)	.16	.16	.16	.16	.16
PARTS-ENGINES	118.33	118.33	118.33	211.92	211.92
No of engines	2.00	2.00	2.00	2.00	2.00
Cost of engines($)	3046044	3046044	3046044	5455466	5455466
Flight time (bhrs)	.49	.49	.49	.49	.49
Block time (bhrs)	.65	.65	.65	.65	.65
OIL	1.33	1.33	1.33	2.67	2.67
No of engines	2.00	2.00	2.00	2.00	2.00
Oil cost ($/gal)	15.00	15.00	15.00	15.00	15.00
Flight time (bhrs)	.49	.49	.49	.49	.49
Block time (bhrs)	.65	.65	.65	.65	.65
SHP per engine	5500.00	5500.00	5500.00	11000.00	11000.00
ENGINE RESERVES	2.32	2.32	2.32	2.32	2.32
Overhaul cost ($)	1400.00	1400.00	1400.00	1400.00	1400.00
OH time lapse(bhr)	1000.00	1000.00	1000.00	1000.00	1000.00
No of engines	2.00	2.00	2.00	2.00	2.00
Flight time (bhrs)	.49	.49	.49	.49	.49
Block time (bhrs)	.65	.65	.65	.65	.65